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Science Education

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

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A CONSUMER APPROACH TO SCIENCE TEACHING

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A member of the state department of public instruction in a mid-western state recently voiced the opinion that there appears to be little justification for the continuance of science courses in our high schools. This opinion was based on the assumption that science courses and science teaching have little to contribute to the enrichment of the lives of the pupils and to the development for intelligent participation in the world of affairs. While this pronouncement was somewhat extreme and no doubt made to stimulate thinking, it does not take a prolonged search of the literature on present-day science teaching to find that recognized authorities emphasize a serious need for improvement of the present efforts in science instruction. Downing[1] believes that only in a small way have the valuable outcomes of science teaching been achieved. Hunter[2] states that science teaching should be a vital force in the development of useful members of society, but that to date any contribution of this nature has been quite insignificant.

Of course, one should mention that fields other than science and that teachers other than those engaged in science instruction are subject to similar criticisms. Be this as it may, science teachers should become increasingly aware of the shortcomings of their own instructional efforts. Failure on their part to remain receptive to well-founded criticism is a violation of a very fundamental aspect of the scientific attitude which, presumably, science teachers seek to exemplify.

In the materials which follow, it is the purpose to suggest certain aspects of science for which a revised emphasis and improved methods of presentation are nec-

[1] Downing, E. R. "Improved Science Teaching." *School Science and Mathematics* 34: 589–593; June, 1934.

[2] Hunter, G. W. *Science Teaching.* New York: American Book Company, 1934. p. 11.

essary if science is to claim a rightful place in a vitalized curriculum of the elementary and secondary schools. To as great an extent as possible, supporting evidence of a scientific nature has been indicated for the various recommendations; although in certain places the viewpoint has been taken that philosophic considerations are of prime importance, such as is the case in the selection of objectives and the consideration of relative values in general.

CONSUMER VALUES OF SCIENCE

Briggs has suggested that our education should be considered as a continuous process in which people are taught "to do better the desirable things they are likely to do anyway," and that it is also the duty of education "to reveal higher activities and to make them both desired and maximally possible."[3] If this viewpoint is accepted, it follows that curriculum materials and teaching procedures should be selected which will contribute to these ends. Thus, much of our science instruction, in the public schools at least, should involve vital experiences and problems. Herein is suggested the need for a broad type of what might be termed *consumer science,* as contrasted with the producer type of the science specialist. Most of the discussion that follows is concerned with an approach to science teaching in which the consumer values are given primary consideration. In a broad sense, as here interpreted, this involves a type of science instruction which contributes to the development of the abilities, interests, ideals, and understandings that are basic in an intelligent consideration of many important life problems and in the interpretation of natural phenomena.

As early as 1860, Herbert Spencer recognized the principle of relative values in the selection of materials for the curriculum, and he contended that unless the materials were capable of producing "appreciable effects" on "human welfare" they were "comparatively valueless."[4] Although the present conceptions of science and of educational processes differ somewhat from those of Spencer, he should be given credit for recognizing the possibilities of science in achieving objectives which pertain to health, vocation, parental responsibilities, interpretation of national life, and general enjoyment. In a sense, it can be said that nearly seventy-five years ago he recognized some of the important consumer values of science instruction.

In the actual practice of present-day science teaching, it is quite evident that the full significance of the consumer values of science has not been recognized, and only in a limited manner have certain of the possibilities been achieved. Herewith is the chief emphasis in the discussion which follows. Consideration is given to the divisions of consumer science which are related to: (1) the activities of leisure, (2) the development of intelligent purchasers and consumers of commercial products, (3) the development of desirable health habits, (4) the socio-economic betterment of mankind, and (5) the improvement of thinking ability. An attempt has been made to suggest important aspects of these divisions which have been given little or no consideration or which have been taught ineffectively.

CONTRIBUTIONS TO ACTIVITIES OF LEISURE

Whatever else the future may hold in store for humanity, it is becoming more and more evident that there will be an increasing release from the traditional types of drudgery. If the benefits wrought by science are made available to society in general, leisure for the masses will be

[3] Briggs, T. H. "General Science in the Junior High School." *Teachers College Record* 33: 599–609; April, 1932.

[4] Spencer, Herbert. *Education: Intellectual Moral and Physical.* New York: A. L. Burt Company. pp. 5–94.

greatly increased. What should be done with this time and what science can contribute to its intelligent use are aspects which should concern science teachers. Among the possible contributions of science instruction to the wise use of leisure are a development of interests and understandings which will lead to a greater appreciation for the natural environment, to the pursuance of hobbies and unspecialized forms of activity which involve applications of scientific materials, and to the development of a desire to pursue on a relatively high intellectual plane some phase or field of science.

The objective of developing an understanding and appreciation of the environment has been prominent in a large proportion of the lists of objectives for science teaching.[5] Text-book materials, particularly in general science and biology, reflect this emphasis; but the results in terms of developing lasting appreciations and understandings are not encouraging.

In seeking an explanation for this paucity of results, it appears that science teachers must accept a considerable portion of the blame. In a recent study of superstitions and unfounded beliefs it was found that college students have many misconceptions about science which should have been corrected in the science subjects taken in high school and college. In a group of college freshmen, practically all of whom had taken general science, biology, and physics in high school, one-fifth or more were so unfamiliar with the application of scientific principles to the environment that they gave erroneous responses to such situations as the use of the "divining rod" for locating underground ore and water, the acceleration of falling bodies of different weights, various important life activities of animals, and the explanations for important natural phenomena.[6]

[5] Hunter, op. cit., pp. 99–103.

[6] Deyoe, G. P., and Johnson, J. B. From unpublished data.

While these materials represent only one aspect of environmental appreciations and understandings, it is certainly true that we cannot overlook the implications. First-hand contacts coupled with information from the printed page concerning the interesting features of life processes and interrelationships of living organisms, the physical processes of the universe, and man's control over his environment are important considerations in the development of appreciation. The writer has found that students in college science courses usually report the very infrequent use of the field trip in connection with the science subjects previously taken in high school. Too often, in high school and college, our biological laboratories continue to be biological morgues in which dead rather than living materials are studied, and much of the laboratory activity in the physical sciences continues to consist of a deadening routine to "prove" some law or process which has already been proved a thousand times and which could be figured out by an intelligent person without the use of tinker-toy equipment. Such activities not only fail in the development of interests and understandings of lasting value but they consume time which might otherwise be spent in developing worth-while projects in the laboratory or in studying vital problems which would grow out of trips to field and factory.

Science teaching has possibilities for developing an interest and a fair degree of skill for the pursuit of certain hobbies and other leisure-time activities. The possibilities have been overlooked for developing interests and understandings which are related to such hobbies as bird and insect study, geologic formations, gardening, home beautification, the care of pets, and the many activities coincident with the home itself.

Overstreet[7] has stated that many of our

[7] Overstreet, H. A. *We Move in New Directions.* New York: W. W. Norton and Company, Inc., 1933. pp. 229–247.

leisure-time activities are of the "escape" type. These are characterized by activities which have little value in terms of life enrichment and cultural development. He suggests that an adequate form of leisure activity should possess four qualities, namely, self-activity in the selection and pursuit of the activity, a spirit of kinship with the materials involved, a continuous widening of the area of one's interest, and a feeling of fulfillment which grows out of a continued study of some line of human interest such as science, art, literature, craftsmanship, and "human amelioration." Herein is much food for thought for those concerned with making instruction in science increasingly effective in its contributions to leisure-time activities.

THE DEVELOPMENT OF INTELLIGENT CONSUMERSHIP

It is passing strange that so little is being attempted in our schools to educate for the intelligent purchase and consumption of the world's goods. Seemingly, this is an important aspect of worthy home membership, which is so glibly displayed in many lists of general educational objectives but only infrequently in objectives for science teaching. In certain respects the field of health is also involved in this important type of life activity.

It is no idle statement that of all groups of people the consumers are among those most neglected by our schools and other governmental agencies. In terms of quality and price, many purchases are unwisely made by the ultimate consumer. Moreover, many articles and materials are worthless or even inimical to the well-being of the purchasers. Misrepresentation, adulteration, harmful ingredients, and poor workmanship are all brought to the surface by scientific tests; yet little is being done to make the consumers aware of these shortcomings and even less is done to help consumers to intelligently use such information as is available and to supplement it by tests of their own. In certain cases the materials made available in our schools may actually be miseducative in influence, such as is often true in pamphlets which set forth in a biased manner the qualities of certain commercial products. The expenditure by the consuming public of millions of dollars on worthless or harmful cosmetics, tooth pastes, mouth washes, and patent medicines is one aspect of the many which have important educational implications. The exaggerated and misleading claims of advertisers constitute another aspect which requires careful consideration.

To say that public schools should not or dare not attack these problems is to suggest the sidestepping of one of the most important phases of human activity. Tact and carefully planned techniques are of course necessary to avoid possible repercussions from groups strongly imbued with the profit motive. One procedure which has been suggested consists in encouraging the student to make his own interpretations from printed materials and from the results of laboratory projects.[8]

The selection of foods in terms of quality and value is not given adequate consideration in science courses commonly taken by all high-school pupils. In a recent study involving college students, it was revealed that the food values as well as the shortcomings of such common articles of diet as milk, vegetables, meats, and fruits are commonly misunderstood. In an entire class of nearly 50 students not one knew that milk was the best single food source for calcium in the human diet![9]

Harap sets forth suggestions for including in our science courses those materials which relate to food consumption, fuel consumption, housing, household materials, household skills, and clothing consumption,

[8] Schlink, F. J. "Shall the Consumer Have Rights in the Schools?" *Progressive Education* 9: 333–338; May, 1932.

[9] Deyoe, G. P., and Johnson, J. B. From unpublished data.

all of which are definitely concerned with intelligent consumership.[10]

Materials of value for educating the consumer are available from several sources. A recent publication entitled *Consumers' Guide* is now published periodically by the United States Department of Agriculture and is of considerable value for the intelligent selection of foods in terms of costs and food values. Materials of value are also available from the Food and Drug Administration, the Bureau of Home Economics, and other governmental agencies. Some books of value are also on the market. Certain materials based on laboratory tests and other objective criteria for a variety of products, as well as suggestions for science teaching, are available for classroom use at a nominal sum from a private establishment.[11] Science teachers with a fair amount of ingenuity can utilize classroom problems and laboratory exercises which will involve the practical use of such materials and which may lead to other information of value.

DEVELOPMENT OF DESIRABLE HEALTH HABITS

In recent years, considerable progress has been made in our science courses to incorporate materials related to the consumer aspects of health education. This development has been most marked in the past decade and a half. It is rather paradoxical that the physical defects brought to light by the health examinations during the world war were in part responsible for bringing about this changed emphasis in curriculum materials.

Studies of current practices reveal that many of the more progressive of our secondary schools have launched definite health programs in recent years.[12] For subjects in science and physical education, objectives are frequently listed which are related to games and exercises for the enjoyment of leisure in later life, to overcoming physical defects, and to developing desirable health habits, upright character, and proper posture. Health examinations are given in many of the more progressive schools. These features are encouraging, but many of these schools offer no corrective work for remediable defects, and there is little evidence that any marked change in health habits has resulted from the programs as a whole. For example, in a recent study it was shown that out of forty-five million children in our country, there are ten million deficients of which more than 80 per cent are not receiving the necessary attention, even though many such cases could be remedied and prevented.[13]

Several studies have shown that by proper motivation and by the provision for the practice of desirable health habits, the health of school pupils has improved considerably. In other words, the consumer approach to health education has given fruitful results in many instances. Caldwell[14] has found that high-school pupils have many superstitions relative to health. He found that specific instruction in science definitely decreases these unfounded beliefs.

In addition to personal health, there is a need for the consideration of the community aspects of health. Here again, it appears that practical problems and projects which grow out of true-to-life situations are valuable in developing the desirable health habits and attitudes. In the achievement of desirable health behavior, practice appears to be a valuable supplementary aid to materials in which the theory of health education is given consideration.

[10] Harap, Henry. *The Education of the Consumer.* New York: Macmillan Company, 1929. 360 p.

[11] Consumers' Research, Inc., Washington, N. J.

[12] *Health Work and Physical Education.* Bul. 1932, No. 17. Washington, D. C., Office of Education, Department of Interior, 1933. 97 p.

[13] *White House Conference,* 1930. New York: The Century Company, 1931. p. 8.

[14] Caldwell, O. W., and Lundeen, G. E. "Changing Unfounded Beliefs." *"School Science and Mathematics* 33: 394–413; April, 1933.

IMPLICATIONS FOR THE SOCIO-ECONOMIC BETTERMENT OF MANKIND

We hear much these days about science remaking the world. Our textbooks and courses of study include many references to the scientific achievements of this age. That these features are important, few or none will deny. However, it seems proper to consider whether or not the gains in standards of living, in security, and in human happiness have been commensurate with the discoveries of a scientific age. Moreover, it seems appropriate to consider whether or not science teaching should be concerned in part with certain of these socio-economic implications.

Science teaching, in raising the question "To what extent has science remade the world?" can scarcely avoid the question "How much has science been permitted to remake the world?" In a consideration of curriculum objectives and textbook materials it is quite evident that this latter issue has seldom been considered as an integral part of science teaching. As recently as the latter part of the last century, one of the greatest obstacles to the social utilization of scientific discoveries was the prejudiced and stereotyped thinking of the people, but today it must be recognized that one of the greatest obstacles has taken the form of a prostitution of science for selfish gain.

At the turn of the present century, a German scientist, Ostwald,[15] foresaw the rapid development of energy and the emergence of a power age. He proposed a science of "energetics" in which due consideration would be given to the utilization of this energy by society on the basis of the greatest good for the greatest number. Today, in an age of machinery and other scientific developments beyond comparison with those of a generation ago, the need for an intelligent integration of the social with the scientific is more imperative than ever. Rugg[16] has suggested the need for uniting technology with democracy to form a "great technology" whereby a civilization of "abundance, tolerance, and beauty" is made possible. Wallace[17] has emphasized synthesis in his "scientific-engineering approach to civilization." There is a need for an emphasis in *science teaching* which will provide insights into the many problems and intricate relationships that are involved in utilizing for the welfare of society the contributions of a scientific age.

In the preceding consideration of activities of leisure, it was pointed out that science has provided the potentialities for greatly increasing the time for such pursuits, and also that science is rich with materials for the worthy use of this leisure. This is all very well; but in any thorough treatment of these phases in science teaching it would be difficult to avoid consideration of the fact that the great masses of people are still so insecure and underprivileged that even if increased leisure has become an actuality the victory is a hollow one. Lorado Taft, the great sculptor, has recently stated that "with most of us the chief pre-occupation of life is its continuance. The stern business of making a living is so desperate that few think of making a life. We live in a world of beauty, are immersed in it, yet we seldom see it!"[18]

The possible contributions which science teaching may render in the development of intelligent consumership have been suggested. However, in any treatment of this important subject, the far-reaching influences of certain profit-motivated forces of society become strikingly evident. For a concrete illustration, one has only to review

[15] Ostwald, Wilhelm. "Zwölftes Kapitel, Soziologische Energetik." *Wissen und Können.* pp. 166–167. Leipzig, 1908.

[16] Rugg, Harold. *The Great Technology.* New York: John Day Company, 1933. 308 p.

[17] Wallace, H. A. "The Engineering-Scientific Approach to Civilization." *Rural America* 12: 3–6; April, 1934.

[18] Taft, Lorado. News items from *The Capital Times,* Madison, Wisconsin. October 23, 1934, p. 2.

the amazing events that were associated with the discussion, emasculation, and final collapse of a much-needed revision of the Federal Food and Drug Act. It is difficult to imagine how the attempt to educate for more intelligent consumership can be divorced from a consideration of these socio-economic implications.

Likewise, the need for more effective health education has been emphasized. In any adequate treatment of the problems of health, it is practically impossible to avoid the social and economic implications. For example, many cases of health deficiencies are due in no small measure to the low economic status of certain members of society. There is evidence to show that for this reason millions of children in the United States are suffering from malnutrition, poor housing, and mental disturbances associated with feelings of insecurity.[19] Of 300,000 crippled children in the United States, more than 90 per cent are entirely unable to pay for the surgical care for the rehabilitation treatment which modern medical science has perfected.[20] Consumption of milk by nearly thirty thousand families in 59 cities was shown to average only slightly more than one pint per person per day, and in one family of seven no fresh milk was purchased at all.[21] Here again, the economic aspects are undoubtedly of prime significance.

In addition to the preceding, there are many other ways in which the welfare of society has been disregarded in the utilization of scientific discoveries. Among these are: (1) the traffic in human blood which is associated with the use of science in perfecting instruments of warfare; (2) the suppression or actual sabotage of inventions by powerful interests strongly imbued with the profit motive; (3) the failure to improve certain products from the standpoint of consumer value even though little or no increase in production costs would be necessary; (4) the creation of an artificial scarcity of necessities and comforts in a period of potential plenty; (5) the colossal squanderings of natural resources; and (6) the tremendous waste of man power due to enforced idleness, parasitic occupations, and obsolescent machinery.[22]

An intelligent consideration of such problems requires the study of the contributions of science in relation to the world of affairs. As stated by Taylor, the broad problem involved is this: "How can we develop and utilize the nation's tremendous natural resources—agricultural and industrial—by applying to them, for the benefit of all the people, everything that we know or can learn about science, trade, commerce, and finance?"[23] If the general problem is accepted somewhat as stated, science teachers must recognize the overlapping relationships of scientific knowledge with the socio-economic aspects of a modern society. Such considerations are basic to an adequate study of many vital problems of the present day. In other words, these socio-economic implications are an integral

[19] Children's Bureau of United States Department of Labor. Release of July 28, 1933. (Reference from Eddy, Sherwood. *Russia Today.* New York: Farrar and Rinehart, Inc., 1934. p. 262.)

[20] Division of Orthopaedic Surgery, University of Chicago. From materials at Century of Progress exhibit.

[21] *Consumers' Guide.* Vol. 1, No. 25, Sept. 17, 1934. p. 2.

[22] Some references among the many used for this section are:

Chase, Stuart. *The Economy of Abundance.* New York: The Macmillan Company, 1934. 327 p.

Rugg, Harold. *The Great Technology.* New York: The John Day Company, 1933. 308 p.

Fraser, F. J. "Big Business Smashes the Machine." *Common Sense* 3: 6-9; October, 1934, and 3: 19-22; November, 1934.

Palmer, D. H. "Mechanical and Electrical Goods for the Consumer." *Annals of the American Academy of Political and Social Science.* Philadelphia: May, 1934.

Recent investigations of the Nye committee on armaments, and various publications in this field.

[23] Taylor, C. C. "Rural Youth and the New Deal," Address delivered before the Second Collegiate Country Life conference, University of Wisconsin, May 12, 1934.

part of a *consumer approach* to science teaching.

IMPROVEMENT OF THINKING ABILITY

In the objectives frequently listed for various science subjects, considerable importance is attached to the development of thinking ability. This is certainly an important aim for *consumer science,* as indicated in the following:

> Science is both organized knowledge and method, and the latter is more important than the former in the life of the average man, for he is bound to encounter many problems which will be successfully solved only as he is skillful in accurate scientific or reflective thinking, while needed knowledge can be obtained from books as occasion arises.[24]

It has frequently been assumed that science in our public schools has contributed greatly to the development of skill for scientific thinking. After testing the assumption, Downing found "no evidence. . . that high-school pupils acquire skill in scientific thinking as a necessary by-product of the study of scientific subjects as at present taught."[25] In casting about for an explanation for this somewhat disappointing conclusion, it soon becomes evident that most science texts and probably very little of the actual teaching contribute to the development of this type of ability. It is small wonder that superstitions, unfounded beliefs, dogma, and inaccurate and prejudiced thinking continue to have a strong grip even on many of the people who have been exposed to the usual run of science courses. Dewey emphasizes these shortcomings in the following:

> (The) responsibility of science cannot be fulfilled by educational methods that are chiefly concerned with the self-perpetuation of specialized science to the neglect of influencing the much larger number to adopt into the very make-up of their minds those attitudes of open-mindedness, intellectual integrity, observation and interest in testing their opinions and beliefs that are characteristic of the scientific attitude. . . . As long as acquisition of items of information, whether they be particular facts or broad generalizations, is the chief concern of instruction, the appropriation of method into the working constitution of personality will continue to come off a bad second.[26]

Tyler[27] has shown that the correlation between the knowledge of informational content in a given science field and the ability to think in the materials of that field is so low that the former is practically of no value in predicting the latter. In spite of this, both in teaching and testing procedures the major emphasis continues to be placed on the former of these two types of learning products.

The thinking demanded in life appears to be associated with some type of problem situation in which there is some perplexity, confusion, or doubt. It is therefore reasonable to assume that thinking of the type needed in life can be stimulated and developed by utilizing representative problem situations. It has been shown that such procedures coupled with careful guidance will result in increased facility in problem-solving and other desirable types of outcomes.[28]

Texts for certain science subjects are now appearing in which the problem-solving approach is followed. However, many of these so-called problems are little more than questions which may require practically no scientific thinking. Very few would be rated high on the five-fold standard suggested by Lancelot.[29] He proposes that problems should be based upon *true-to-life* situations, be of *proper scope* and

[24] Downing, E. R. "Does Science Teach Scientific Thinking?" *Science Education* 17: 87–89; April, 1933.

[25] Downing, *ibid.*

[26] Dewey, John. "The Supreme Intellectual Obligation." *Science Education* 18: 1–4; February, 1934.

[27] Tyler, R. W. *Constructing Achievement Tests.* Columbus, Ohio: The Ohio State University, 1934. p. 5.

[28] Downing, E. R. "Methods Versus the Mechanics of Instruction." *Science Education* 16: 468–474; December, 1932.

[29] Lancelot, W. H. *Handbook of Teaching Skills.* New York: John Wiley and Sons, Inc., 1929. pp. 116–130.

difficulty, require *thinking* of superior quality, be *interesting,* and be *clear* and *definite* in statement.

Many problems acceptable for science teaching will grow out of the experiences of the teachers and the pupils. Some of the general areas in which these problems will arise have been suggested in the preceding portions of this article. The utilization of these problems for vital teaching situations constitutes the central feature of the consumer approach to science teaching.

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A SIMPLE APPARATUS FOR DEMONSTRATING THE ACTION OF THE HEART AND CIRCULATION OF THE BLOOD

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The heart and circulation model here described is of fundamentally simple design and can be assembled from standard laboratory equipment in less than two hours' time. Its construction may serve as an excellent project for a group of two or three students of average ability. It is sufficiently large to be used in lecture-table demonstration before a class of thirty or forty students, and will operate automatically and continuously without attention. The moving parts of the apparatus (Fig-

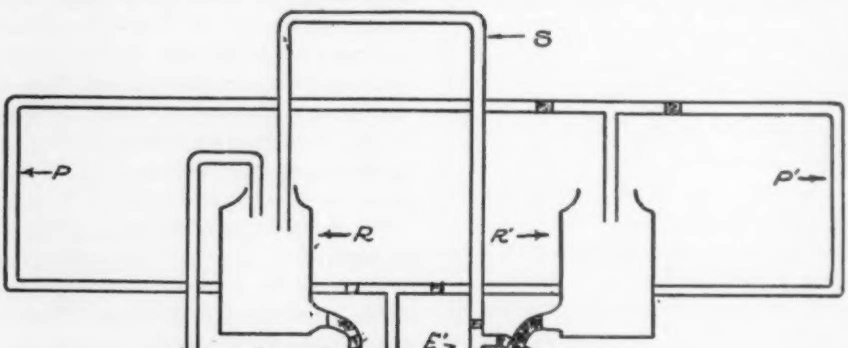

FIGURE I

ure I) are a modification of the "balloon pump" described by J. Palmer.[1]

To represent the heart two reservoirs R and R′ (auricles) are connected with the balloons B and B′ (ventricles) of the pumps. Flap valves V and V′ prevent reversal of flow during contraction of the balloons which are activated by a stream of compressed air which enters the glass cylinders C and C′ through the glass tubes J and J′. The pressure of the liquid entering B and B′ holds the the tips of the balloons down against the openings of the exhaust tubes K and K′ making a firm closure. Tubes K and J′ are connected in series so that the action of the two pumps is simultaneous. While the pressure of air in the cylinders is increasing, liquid is being forced out of the balloons by way of tubes E and E′ until the tips of the balloons finally are drawn away from the exhaust tubes. The air pressure in the cylinders immediately falls, allowing the balloons to fill again from the reservoirs and so close the exhaust tubes for the beginning of another "beat." The rate of beating can be regulated by adjusting the flow of air through the cylinders.

The pulmonary and systemic circuits are represented by the bent glass tubes P, P′ and S, S′ respectively. If desired, the anatomical details of these circuits can be followed more exactly by bending the glass tubing into suitable form, likewise additional flap valves may be interposed at correct locations in the circuits.

Flap valves V and V′ are made by sewing a small semicircular piece of rubber balloon or a piece of dentist's rubber dam along the edge of a two holed-rubber stopper. This flap should cover one of the holes, but not so tightly that the flow of liquid is greatly restricted. B and B′, balloons, or better still large rubber finger stolls, are now slipped over the small ends of rubber stoppers. Three to five cc. of mercury may be dropped into each balloon to insure positive contact with the exhaust tubes. It is well to lubricate K and K′ with glycerine in order that they may be easily moved in making adjustments. Instead of the aspirator bottles illustrated in Figure I, tall separatory funnels may be used as the reservoirs R and R′.

An effective way to begin a demonstration with the apparatus is to fill each reservoir half full of water and start the pumps "beating"; then after adding a few cc. of strongly colored congo red solution to R (right auricle) one may observe the colored liquid flowing into B (right ventricle), around through P and P′ (pulmonary circuits) to R′ (left auricle), into B′ (left ventricle), around through S and S′ (systemic circuits) and finally returning to R. The direction of flow can be traced again and again by alternately changing the color of solution by adding at R and R′ small amounts of moderately strong acid or base.

Likewise the oxygen carrying power of defibrinated blood or oxalated blood may be readily demonstrated. If a stream of nitrogen or other inert gas is bubbled rapidly through the blood in R, this blood becomes relatively deoxygenated and assumes a typically dark color. Similarly a rapid stream of oxygen or air bubbles through the blood in R′ causes a reversion of an arterial condition of bright scarlet color. It is evident that, while the model is working, oxygen is carried from R′ to R where it is liberated into the room air.

[1] Palmer, J. *Science News Service* 80: 229–230, 1934.

HOW COULD A NATIONAL ORGANIZATION COORDINATE THE ACTIVITIES OF EXISTING SCIENCE TEACHERS' ASSOCIATIONS?

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Existing natural science associations—city, county, state, sectional, or national—should have aims and objectives which are, at least harmonious. There may be differences in the direction and amount of emphasis and there is, without a doubt, an overlapping in some particulars. Because of this condition, there are numerous opportunities for mutual helpfulness.

Groups of natural science teachers, in working on cooperative projects, will be largely influenced by their group memberships. Sometimes an overlapping in these efforts is planned, but more often it is accidental. Teachers who are thrown together during graduate study, or who are subject to the stress of research as published in periodicals, will account for yet other cases where cooperative projects are in progress. If the truth were known it would perhaps reveal not only many groups struggling to maintain an active membership, but, as well, a few groups where constructive endeavors are bringing positive results. It is a well known fact that a group prospers under the influence of challenging leadership, and struggles along and deteriorates during periods of less virile leadership.

Group meetings are planned for most organizations by an individual or a small committee. Suggestions for an appropriate program from the entire group are commonly few. Funds available are usually limited or entirely lacking. A section meeting devoted to the consideration of natural science is often assigned a small room in order to make the larger auditoriums available for more agressive sections. An hour or two often constitutes the entire allotment of time for the section. A speaker on some propogandistic topic may be recommended for the program by some national organization as a worthy lecturer and the suggestion is made that the natural science section use this lecturer. This helps to complete a program for a busy section chairman. Thus plans are completed, the section meets, the speakers speak, a new chairman is elected and about eleven months later a new program will be planned. It is frequently true that the activities of natural science sections for different districts within the same state teachers association do not present to the teachers a single common inspiration, or a single common challenge to do something about a mutual and state-wide need.

How could a national organization coordinate the activities of existing science association? The answer appears obvious. It could coordinate the activities in the same general manner as a state organization coordinates the activities of various district sections; in the same general manner as a science committee can coordinate activities in like courses or classes within a school system; and in the same general manner as a natural science teacher can coordinate the activities of students working as groups under a "group plan" of instruction.

What are the factors in coordinating activities of two or more groups? One factor is a representative membership. This can be by (a) an unplanned overlapping of membership, or by a definite and planned representation; (b) by an

* Paper read at the meeting of Teachers of Science planned by the Committee on the Place of Science, Pittsburgh, December, 1934.

exchange of speakers on the basis of reputation and remuneration, or by a planned exchange of speakers on the basis of group needs and a speaker's ability.

A complete overlapping between all groups in a national organization is impossible. Overlapping of one group in another group is entirely feasible as evidenced by several groups now functioning on this basis. For real and definite representation it is unavoidable that there be overlapping within one group. If a parent or primary organization exists let it be used; if there are several primary national organizations, the need for a coordinating group is real. It may also be added that a definite and planned representation is more apt to secure generally beneficial results than an unplanned overlapping. It is also true that the group most poorly organized and therefore least able to pay would be the one most in need of the best speakers. A national group could select or encourage the selection of able and responsible representatives. It could perhaps help to defray traveling expenses either directly or indirectly so that this item would not become a personal burden. The national group could suggest speakers for the treatment of certain problems and could arrange tours so that expenses would be kept at a minimum, and it could assume part of these expenses.

Another factor in coordinating activities of groups is printed material, either as correspondence, bulletins, or periodicals. Many groups would be glad to arrange programs stressing timely topics if suggestions were available in sufficient time and in sufficient detail. The distribution of a set of suggestions which represent the viewpoints of teachers served by the group, is often very helpful. Many of these suggestions are sufficiently general to be principles for guidance in planning programs for any section or group. Innovations from successful programs could be discussed and unsuccessful procedures could be presented with safeguards. The challenge to a chairman for early planning of a program in order to have it appear in an announcement is also of definite help. Such early planning might lead to correspondence in which certain speakers or other improvements are suggested.

While the matter of abstracting articles for science teachers is reasonably well carried out, it would appear that a "Science Teachers Digest" would be a helpful coordinating factor. In addition to abundant abstracts, this could contain brief presentations of suggestions regarding books, charts, teaching plans, slides, and a multitude of other teaching aids. Perhaps the abstracts and notes from numerous periodicals could be brought together and classified for teachers of natural science.

A third factor in coordinating the activities of existing science organizations is the radio. A group charged with coordinating activities could sponsor and direct national radio presentations which are of definite value to science teachers and their pupils. Natural science teachers and groups of teachers could be informed of these broadcasts in advance. They could plan their own program so as to make possible the hearing and discussing of the radio presentation as a part of their local program. Business organizations are using telephonic connections to bring reports and suggestions to sales groups. Is it too much to expect that natural science teachers in a strong national organization may be served similarly?

Another use for the radio would be to arrange for the broadcast of prominent speakers at distant meetings. Many science teachers scattered over the country may well be challenged by the speakers who appear on programs as, for example, the noon address today of Dr. Thorndike. Classroom teachers not responsible for science subjects would have been stimulated and challenged by planning of this kind. Small organizations cannot accom-

plish much in national program making, but a group coordinating and serving all groups of similar interests may achieve goals which, up to the present, have been unattained.

In summarizing our personal views, and those of local and more distant contributors, it may be said that a national group could coordinate the activities of existing science organizations by the following means:

1. Developing a strong national group, or correlating closely the activities of existing national groups. Planning for a large membership with conservative dues.
2. Encouraging and securing alert personal representation from all local groups in the national group. This representation to be as direct as possible.
3. Stimulating and guiding the organization of new groups and engendering new enthusiasm in older groups.
4. Assisting in scheduling and presenting an exchange of speakers.
5. Distributing printed suggestions for program-making to local groups.
6. Securing and publishing preliminary programs and following this with definite suggestions for improvement.
7. Publishing reviews of recent materials of aid to natural science teachers, perhaps in a "Science Teachers Digest."
8. Arranging for a reporter at all local meetings to be followed by the publication of constructive comments.
9. Sponsoring and directing national broadcasts of prominent speakers on problems clearly related to natural science teaching. Cooperating with "Science Service" may bring this to an early realization.
10. Arranging for the broadcast of prominent and challenging speakers at distant meetings of natural science teachers. Encouraging science teachers to hear and discuss these presentations at local meetings.
11. Arranging for the presentation of brief reports and stimulating plans by means of telephonic services. Encouraging several groups to meet simultaneously for such presentations.

METHODS OF RECORDING LABORATORY NOTES IN HIGH-SCHOOL CHEMISTRY

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PURPOSE OF THE INVESTIGATION

The purpose of this investigation is to compare the effectiveness of three methods of recording laboratory notes in high-school chemistry.

It was found, upon looking through fifteen laboratory manuals in high-school chemistry, that there was no general agreement among the authors as to the best method of recording laboratory notes.

SETTING OF THE INVESTIGATION

This investigation was conducted in the Whiting Senior High School, Whiting, Indiana. Each of three classes in chemistry was divided into two sections. Each section recorded its laboratory notes according to one of three methods which were designated as Method I, Method II, and Method III.

In the first class, Method I was compared with Method II. In the second class, Method I was compared with Method III. In the third class, Method II was compared with Method III.

Method I consisted of answering all

questions, writing equations, and following all directions in the laboratory manual[1] during the experiment, followed by a connected account written on theme paper in the class room on the following day. This account of the experiment was written under the following divisions: title, apparatus, materials, observation and data, and conclusion. No drawings were permitted.

Method II consisted of answering all questions, writing equations, and following all directions in the laboratory manual during the experiment. No further notes were prepared in this method. No drawings were permitted.

Method III consisted of answering all questions, writing equations, and following all directions in the laboratory manual during the experiment followed by a written exercise. This exercise consisted of a small number of questions and suggestions designed to emphasize the important parts of each experiment. These questions and suggestions were completed by the student in the class room on the day following the experiment. No drawings were permitted.

The common factor in these three methods consisted of answering all questions, writing equations, and following directions in the laboratory manual during the experiment. The point of difference in these three methods lay in the fact that a permanent notebook was kept in Method I, no notes were kept in Method II, and study questions were answered in Method III.

SAFEGUARDS AGAINST MORE THAN ONE VARIABLE

Paired students worked as laboratory partners in order to increase the chances of gaining equal information from the experiment.

All sections were given exactly the same reading assignment. The method and content of each discussion were kept as nearly constant as possible through reference to the teacher's written notes on the plan of the discussion.

Students' written work was done in the class room under the immediate supervision of the teacher. The source of information consisted of notes in the laboratory guide taken at the time the experiment was performed. Notebooks were kept in the laboratory.

NUMBER AND DESCRIPTION OF TESTS

Measurement of individual success in each method consisted of twenty-six separate tests. Each test covered a laboratory experiment. Each test included ten items of the blank space type designed to measure the retention of factual material such as the names of formulas, formulas for chemical compounds, methods of procedure, chemical reactions, and preparation and properties of substances.

PROCEDURE IN GIVING TESTS

All sections were given the same test on the same day one week after each experiment had been done. In the meantime, written work as required by the different methods had been completed according to schedule. Three weeks subsequent to the performing of each experiment, the same test was repeated to measure delayed retention.

The method employed for scaling test items was that described by Holzinger.[2]

PAIRING THE STUDENTS

Students were paired on the basis of grade classification, chronological age, first semester grade in chemistry, I.Q., and sex.

First semester grades in chemistry were a matter of record. They were obtained by means of tests covering readings and experiments. They represented the student's accomplishment in chemistry at the close of the first semester.

[1] Raymond B. Brownlee and others. *Laboratory Exercises in Chemistry.* New York: Allyn and Bacon, 1932. Pp. xii–304.

[2] Karl J. Holzinger. *Statistical Methods for Students in Education,* pp. 224–29. Boston: Ginn and Company, 1920.

Chronological age was computed to the nearest month from records available in the principal's office at the beginning of this investigation.

Intelligence quotients were obtained by taking the mean of I.Q. scores made by each student on the Henmon-Nelson Test[3] and the Otis Test.[4]

ANALYSIS OF TEST SCORES

The mean of a series of means was determined for each method. A statistical comparison of these two means was then made by determining the probable error of each mean by using the formula,[5] $P.\,E._m = .6745\ \frac{\sigma_x}{\sqrt{N}}$.

In order to determine the significance of these two means, the probable error of their difference was determined by substitution in the formula,[6] $P.E._{m_1-m_2} = \sqrt{(P.\,E._{m_1})^2 + (P.\,E._{m_2})^2}$.

TABLE I

DATA CONCERNING THE STATISTICAL SIGNIFICANCE OF METHODS I, II, AND III

Immediate Recall

Method	*Mean*	$P.E._m$	$P.E._{m_1-m_2}$	*Diff. Between Means*	$4(P.E._{m_1-m_2})$
I ...	26.57	.596	.917	2.98	3.668
II ...	23.59	.698	....	...	....
I ...	26.93	.561	....	...	....
III ...	29.64	.593	.816	2.71	3.264
II ...	24.82	.602	....	...	....
III ...	29.30	.607	.845	4.48	3.416

A difference between two statistical constants, such as two means, in order to be significant, should be at least four times its probable error.[7]

Table I includes data which were used in determining the significance of the difference between two means. For immediate recall, neither Method I or Method II is superior. Neither Method I or Method III is superior, but Method III is shown to be statistically superior to Method II.

TABLE II

DATA CONCERNING THE STATISTICAL SIGNIFICANCE OF METHODS I, II, AND III

Delayed Recall

Method	*Mean*	$P.E._m$	$P.E._{m_1-m_2}$	*Diff. Between Means*	$4(P.E._{m_1-m_2})$
I ...	26.93	.628	1.012	1.35	4.048
II ...	25.58	.796	....	...	....
I ...	27.04	.729	....	...	....
III ...	30.63	.708	1.016	3.59	4.064
II ...	26.17	.563	....	...	....
III ...	29.33	.607	.796	3.16	3.184

For delayed recall, Table II shows that neither Method I or Method II is superior. Method I is not superior to Method III nor vice versa. Method III is shown to be superior to Method II if the data concerned are considered to one decimal place only.

Table III shows immediate and delayed test mean scores for all three methods of recording laboratory notes. It has been shown statistically that Method I is not superior to Method II, although the mean of Method I exceeds the mean of Method II by 2.98 and 1.35 for immediate and delayed recall respectively. This difference may be attributed to chance fluctuations in the sample. The delayed test mean scores for Method I and Method II exceed the corresponding immediate test mean scores by .36 and 1.99 respectively. Delayed mean scores exceed immediate mean scores in

[3] V. A. C. Henmon and M. J. Nelson, *Henmon-Nelson Test of Mental Ability, Form A.* Boston: Houghton Mifflin Co., 1929.

[4] Arthur S. Otis. *Otis Self-Administering Test of Mental Ability Higher Examination, Form B.* Yonkers-on-Hudson: World Book Co., 1922.

[5] Karl J. Holzinger. *Op. cit.*, p. 233.

[6] *Ibid.*, p. 235.

[7] *Ibid.*, p. 237.

all of the six cases for which reasons are offered in a subsequent paragraph.

Table III
Comparison of Means for all Methods
Immediate and Delayed Recall

Method	*Immediate Recall*	*Delayed Recall*
I	26.57	26.93
II	23.59	25.58
I	26.93	27.04
III	29.64	30.63
II	24.82	26.17
III	29.30	29.33

It has been shown that Method III is not superior to Method I, although the mean of Method III exceeds the mean of Method I by .271 and 3.59 for immediate and delayed recall respectively. The delayed test mean scores for Method I and Method III exceed the corresponding immediate test mean scores by .11 and .99 respectively.

It has been shown that Method III is superior to Method II for both immediate and delayed recall. The delayed test mean scores for Method II and Method III exceed the corresponding immediate test scores by 1.35 and .03 respectively.

Possible reasons why delayed mean scores exceed immediate mean scores in every case are: (1) Some students may have voluntarily reviewed the experiment during the time following the first test and preceding the second test, although actual formal work on the experiment, including written work, was done in the laboratory and class room under close supervision and according to a strict schedule. Furthermore, note books and laboratory manuals were never removed from the laboratory or class room during this investigation. Although it is possible to control the mechanical details of such an investigation, it is not possible to control thought processes in the student's mind after he has left the laboratory or class room. During such time ideas may have become clarified and fixed which at the time of the first test were entirely misunderstood; (2) Information from closely or partially related experiments may have carried over; (3) The time element necessary for the clarification of patterns of understanding may have been a factor in increased learning.

Table IV shows the per cent of individual scores favorable to different methods of recording laboratory notes for immediate recall among high, medium, and low I.Q. groups. Although Method I has been shown not to be superior to Method II in a class consisting of high, medium, and low I.Q. students, these percentage figures indicate the relative effectiveness of the two methods when applied to high, medium, and low I.Q. groups separately.

Table IV
Per Cent Favorable to Different Methods in High, Medium, and Low I.Q. Groups

Immediate Recall

Method	*High I.Q.*	*Medium I.Q.*	*Low I.Q.*
I	54.1	53.0	61.9
II	40.1	45.0	36.5
Tied	5.8	2.0	1.5
I	36.1	36.7	42.8
III	57.7	56.1	55.9
Tied	6.0	7.1	1.1
II	38.3	41.4	19.8
III	57.5	55.6	75.2
Tied	4.0	2.8	4.9

Taking into consideration the possibility of adding percentage figures for those tied to either Method I or Method II, we find the greatest difference in favor of Method I in the low I.Q. group, the next greatest difference in favor of Method I in the high I.Q. group, and the third greatest difference in favor of Method I in the medium I.Q. group. These differences are 26.9, 19.8, and 10.0 respectively when the percentage figures for those tied are added

to Method I. When the percentage figures for those tied are added to Method II, the differences favoring Method I are 23.9, 8.2, and 6.0 for low, high, and medium, I.Q. groups, respectively. In either case these percentage figures indicate clearly the superiority of Method I over Method II for the low I.Q. group as compared with the relative effectiveness of the two methods when applied to medium and high I.Q. groups. These data show that a permanent notebook is more profitable for low I.Q. students than for high or medium I.Q. students.

For a class consisting of high, medium, and low I.Q. students, it has been shown that Method I is not superior to Method III nor vice versa. However, the percentage figures indicate the comparative effectiveness of these two methods when applied to high, medium, and low I.Q. groups separately. If the percentage figures of those tied are added to those for Method I, we find the differences in favor of Method III in the order of high, medium, and low I.Q. groups. These differences are 15.6, 12.3 and 12. When the percentage figures for those tied are added to Method III, and differences favoring Method III, are 27.6, 26.5, and 14.2 for high, medium, and low I.Q. groups respectively. In the first case these differences are too small to justify any claim for the superiority of either method in any of the three I.Q. groups. In the second case the figures indicate the superiority of Method III for high and medium I.Q. groups. However, such a conclusion is not justified from these data, especially in view of the fact that neither method was shown to be superior by statistical treatment when applied to a class containing high, medium, and low I.Q. students.

It has been shown that Method III is superior to Method II for a class consisting of high, medium, and low I.Q. students. In order to compare the effectiveness of these two methods of recording laboratory notes when applied separately to high, medium, and low I.Q. groups, let us consider the percentage figures which apply to these three groups. If the percentage figures of those tied are added to those for Method II, we find the differences in favor of Method III in the order of low, high, and medium I.Q. groups. These differences are 50.5, 15.2, and 11.4. When the percentage figures for those tied are added to those for Method III, the differences favoring Method III are 60.3, 23.2, and 17.0 for low, high, and medium, I.Q. groups respectively. These figures indicate clearly the effectiveness of Method III for low I.Q. students over high and medium I.Q. students.

Table V

Per Cent Favorable to Different Methods in High, Medium, and Low I.Q. Groups

Delayed Recall

Method	*High I.Q.*	*Medium I.Q.*	*Low I.Q.*
I	49.0	40.2	58.6
II	38.8	58.6	39.6
Tied	12.0	1.1	1.7
I	35.0	42.7	26.7
III	58.4	55.0	69.0
Tied	6.5	2.2	4.2
II	38.2	45.4	26.3
III	52.8	53.0	71.4
Tied	8.9	1.5	2.2

Table V shows the per cent of individual scores favorable to different methods of recording laboratory notes for delayed recall among high, medium, and low I.Q. groups. A comparison of Method I with Method II for the high I.Q. groups shows that 49 per cent of the total number of individual test scores favor Method I, 38.8 per cent favor Method II, and 12 per cent are tied. Considering the possibility of adding the percentage figures for those tied to those of either method, we find 61 per cent in favor of Method I as compared with 38.8 per cent in favor of Method II. If the percentage figure for those tied is

added to Method II, we have 49 per cent in favor of Method I as compared with 50.8 per cent in favor of Method II. This shows little choice between Method I and Method II for the high I.Q. group. Comparison of percentage figures in a similar way in the medium I.Q. group shows a choice in favor of Method II. Figures for the low I.Q. group show a choice in favor of Method I.

Comparison of the percentage figures favoring Method I and Method III shows that Method III is most effective in the low I.Q. group, next most effective in the high I.Q. group, and least effective in the medium I.Q. group. The large percentage of scores of low I.Q. students which favor Method III indicates the desirability of low I.Q. students writing their laboratory notes according to a method which induces some thinking in terms of the important points in an experiment rather than writing their laboratory notes according to a scheme which permits of more or less mechanical procedure.

Percentage figures show a decided choice in favor of Method III over Method II for low I.Q. students. Medium and high I.Q. students, likewise, favor Method III, but there seems to be little choice between the two methods by the two groups. Again, these figures indicate the advisability of allowing the lowest I.Q. students in the class to write their laboratory notes according to a plan which points out and encourages some thinking concerning the important points in an experiment in preference to writing no notes in addition to those taken down at the time the experiment was performed.

CONCLUSIONS

1. The writing of a permanent notebook does not increase immediate or delayed retention of facts for an average class consisting of high, medium, and low I.Q. Students.

2. The permanent notebook is used to advantage by a larger per cent of low I.Q. students than it is by high or medium I.Q. students.

3. For the average class consisting of high, medium, and low I.Q. students, a written exercise, in which the student answers questions designed to emphasize the important parts of an experiment, is as effective as a permanent notebook.

4. For the average class, the method of writing answers to questions designed to emphasize the important parts of an experiment increases immediate and delayed retention of facts.

5. The method of writing answers to questions is used to advantage by a larger per cent of low I.Q. students than it is by high or medium I.Q. students.

6. The writing of detailed notes is not justified for all students. The method is helpful to low I.Q. students.

A SIXTH-GRADE UNIT IN ELECTRICITY

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Almost every boy and girl finds great fascination in any kind of work with electricity. The average child in the sixth grade is curious to know what electricity is and to know what he can do with it. Many of them find great satisfaction in the experiments they can perform with a little wire, some dry cells, and a book of simple experiments to serve as a guide.

Children's interest alone in the subject would probably not be sufficient justification for the teaching of this topic. But, since electricity influences the child's life in so many ways, some knowledge of the

subject may have a very practical value. While there is considerable variation in the topics covered in a science course for the intermediate grades, there seems to be considerable agreement in giving some place to electricity. According to Parker, "Devices operated by electricity now make up so conspicuous an element of our environment that every child has a right to be taught something of the ways in which electricity has been harnessed to help us."[1]

With the belief that a unit in electricity meets the criteria of both natural interest and usefulness, it was given a place in our science course for the sixth grade and the following objectives were established:

To increase the child's knowledge of the nature of electricity and its uses.
To help the child to gain skill in handling simple wiring problems in the home, and to acquaint him with the necessary precautions.
To develop in the child an appreciation of the rapid growth of man's knowledge of electricity and its uses in the last century.
To develop an appreciation of man's dependence upon electricity for work and comforts.

Since the children understood that electricity was one of the units of work in science, they began very early to consider what activity they might carry on. Many suggestions were made. The one that seemed to be most popular was that of wiring a house for lights.

The problem suggested seemed practical and interesting as well as worth while from the standpoint of the knowledge of electricity that would be gained. There was sufficient enthusiasm for beginning the work at once, but all realized that they must know something about the nature of electricity, how it is generated, how it is carried, and how it is controlled. Steps were taken to get this information from observation, by experiments, and by reading from available references.

We began our work with a study of how an electric current may be produced. Since most children are familiar with the dry cell and since it was the source of the power used in all our experiments, we considered it first. From their experiences with the dry cell the children recognized it as a safe source of power, but one that could be used for a limited time only. They examined an old cell to find how it was constructed and what substances were used in it. A simple cell made by placing a zinc and a copper strip into diluted sulphuric acid gave the children some idea of the chemical action that takes place when a current is produced.

While the current generated by this chemical activity was satisfactory for use for short periods of time as in a flashlight, or for our experiments, the children saw the need of some other means for producing a current that was to furnish power continuously as for lights or electric cars. Attention was called at this time to the power plants in which water power or steam is transformed into electric power. Later, after the class had become acquainted with the magnet and the magnetic effects of an electric current, they learned that electricity can be produced by turning coils of wire through the lines of force of a magnet. A visit to the power plant at this time gave the class some idea of the generators or dynamos which provide electricity for their homes.

Next came the question of how a current of electricity is carried. Attention was called to three requisites: a current, a good conductor, and a complete circuit. The class became acquainted with the substances that were good conductors and those that were poor conductors, otherwise known as good insulators. The wiring of an electric questioner and an electric bell by the children helped to clarify for them the meaning of a complete circuit.

An understanding of the cause and results of a short circuit and of the heating effects of a current of electricity

[1] Parker, Bertha M. *The Book of Electricity.* Boston: Houghton Mifflin Company, 1928. Preface.

explained the purpose of the fuse as a safety device. The children examined the fuse to see what happened when it burned out and thus broke the circuit.

The children learned of the magnetic effects of a current of electricity by noting the deflection of the compass needle when a wire over which a current was passing was brought near. They made an electromagnet by wraping a soft iron nail with several coils of wire and passing a current of electricity through it. This led to a study of the permanent magnets: what substances may be magnetized, how they may be magnetized, and what the properties fo a magnet are. The class noted the advantages of an electromagnet over the permanent magnet and some of the many uses of the electromagnet. Special attention was called to its use in the electric bell. From this study of the magnetic effects of electricity the class learned not only that electricity may be used to make magnets but that magnets can be used to make electricity.

The class noted the conditions under which an electric current produces heat and light and some of the devices in our homes using this heating effect. They read of the many experiments Edison made with different substances in the light bulb before finding a satisfactory one.

A short time was given to a study of static electricity although it had no bearing on our particular problem. The children had often experienced a small shock when sliding out of their seats at school or when walking across a rug with a long nap. By experimenting they learned of different substances that can be electrified by friction. Attention was called to the little use that can be made of this frictional or static electricity since its spark cannot be controlled.

The class became interested in the history of man's knowledge of magnetism and electricity; how early man probably learned of the peculiar behavior of substances that are magnetized; what he learned about substances that could be electrified by friction; how Franklin proved that lightning was a discharge of frictional electricity; and how it was left for man in the last century to learn how to use current electricity.

During all this study the class was looking for information on how buildings were wired for lights. They were observing the arrangement of the wires exposed in the basement of their own homes. Two of the children were fortunate in living in old houses that had been wired recently. In one, all the wires were exposed thus providing an excellent opportunity for examination of the plan. All were consulting references for further information on the subject.

The class learned that there were two possible arrangements of lights on a circuit. Chains of Christmas tree lights were used to illustrate the arrangement of lights in series and in parallel. Experiments readily showed the advantage of the arrangement in parallel over the arrangement in series which led the class to decide to use the parallel arrangement.

When the class felt it knew how to wire a house and was ready to proceed, the question of material arose. First we had to have a house to wire. Various suggestions were made and some volunteered to construct a small house. We were fortunate, however, in finding a house in the school storeroom that had been constructed some time before. It was a two-story frame house about four feet long and three feet wide divided into seven rooms and stairway. This gave an opportunity to put in eight lights. The roof and sides of the house could be removed thus making it possible to reach in to work within the rooms. The other materials used were a cord and sockets of Christmas tree lights, eight 2.5 watt flashlight bulbs, annunciator wire, two dry cells, a switch, and some adhesive tape.

The work was so planned that each child would have an opportunity to help

with some part of the work. Three of the children who seemed to have the clearest understanding of the work to be done were made captains or overseers. They were responsible for seeing that at least one of them was present when any work was being done. The rest of the class was divided into committees, each responsible for putting in at least one light bulb. The work had to be done in the classroom and a large part of it during the school session. This meant that three or four were working at the house while the rest of the class were engaged at some other kind of work.

Before any of the actual work could be done a general plan for the wiring had to be made. Some of the points to be considered were the placing of the lights, the wires, and the batteries. Our problem was to place the lights in desirable positions in the rooms, to keep the wiring problem a simple one, and to hide the wires as far as possible. The problem seemed to be solved most easily by placing the batteries in one end of the attic and running the two lead wires on the floor of the attic the length of the house. Holes were then bored into the second floor rooms at the places where lights were desired. A socket with the attached wires of sufficient length to reach to the lead wires was cut from the chain of lights. This socket was suspended from the ceiling, the wires passed through the hole, and the ends attached one to each of the lead wires. Here was an opportunity to show the importance of scraping off the insulation carefully, wrapping the bare wires securely, and then wrapping all neatly with strips of adhesive tape. Since it did not seem advisable to tear the house apart enough to hide the wires in the rooms of the first floor, the lead wires were brought down along one of the inner partitions, through the floor into the lower rooms, and then carried along the ceiling.

Only one switch was placed in the entire circuit. Wires led from the batteries to the switch which was placed just outside the house. This meant, of course, that all lights were turned on or off at the same time.

We were aware that this wiring problem had been made as simple as possible and differed in many ways from the actual wiring of our houses. Attention was called to some of these differences such as, the arrangement provided for turning the lights on and off in each room, the power plant outside the home, the protection provided by a fuse in each system, and the practice of soldering all connections.

It was with considerable interest that the children closed the switch at the end of their work and saw that it was completed successfully. After a few days the house was packed back to the storeroom. We hope, that, through these concrete experiences, the children gained considerable knowledge of electricity. The unit correlated nicely with other school subjects; for example, it called for a practical use of some arithmetic. The children first needed to make an estimate of the amount of wire to be used and of the cost of the materials before deciding on the plan to be followed. They found it necessary to make very careful and accurate measurements when locating the place for the lights. This problem made good material for composition work. Each child wrote an explanation or description of some part of the work in electricity. This has been collected and bound together and is to be left for the next class. The children of the fourth and fifth grades had exhibited a great deal of interest in the house and the work that was being done. After the wiring had been completed, the sixth grade invited the other intermediate grades to an informal assembly. They explained the meaning of some terms, for example, a complete circuit, and then showed the plan for wiring the house and what some of their problems had been.

They closed by turning on the lights showing what they had accomplished.

After thinking through the entire unit of work, we believe it made some contributions to the following levels of mental content:

Knowledges gained

1. There are two kinds of electricity: static and current.
2. Static or frictional electricity may be produced by rubbing certain substances together, as hard rubber with fur or wool, and glass with silk.
3. Lightning is static electricity.
4. Static electricity has little use since it cannot be controlled.
5. Current electricity may be produced by chemical action.
6. Current electricity may be produced by mechanical energy; by turning a coil of wire through the lines of force of a magnet.
7. A current of electricity can flow only when there is a complete circuit.
8. A current of electricity has magnetic effects.
9. An electromagnet is made by coiling wire around a soft iron core and passing a current through the wire.
10. Copper, many other metals, and water are good conductors of electricity.
11. Rubber, glass, porcelain, and silk are poor conductors of electricity, or good insulators.
12. An electric current heats the wire over which it passes.
13. The greater the resistance of the wire to the current, the more the wire heats.
14. Electricity may be used as power to do mechanical work.
15. In the motor electrical energy is changed into mechanical energy.
16. In the generator or dynamo, mechanical energy is changed into electrical energy.
17. Iron and steel may be magnetized and will attract other iron and steel.
18. A magnet free to swing will take a north and south position.
19. Every magnet has a north and a south pole.
20. Two unlike poles will attract each other and two like poles will repel each other.
21. The earth is a magnet and the north seeking pole of the magnet will point toward the north magnetic pole of the earth.
22. The magnet is surrounded by a field of force through which the magnet exerts an influence.
23. Early man recognized the magnetic effects of some substances but did not understand it.
24. The early Greeks knew that some substances, such as amber, became electrified when rubbed, and from them came the term electron and our word electricity.

Skills practiced

1. Accuracy was required in the measurements.
2. Neatness of work was one of the standards set up.

Social attitudes encouraged

1. There was an opportunity for the acceptance of responsibility.
2. There was an opportunity for cooperation in the division of work among the people in one group.
3. There was an opportunity for cooperation in the division of time between different groups.
4. There was an opportunity to develop a willingness to accept suggestions and criticisms.
5. There was an opportunity to develop a desire to do careful, painstaking work and a corresponding dissatisfaction with slovenly work.

Appreciations strengthened

1. There was a better understanding of the skill required of electricians.
2. There was a better understanding of the power of an electric current and of the consequent need of caution in its use.

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THE MEASUREMENT OF SCIENTIFIC ATTITUDES*

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In speaking of the measurement of scientific attitudes, I cannot give you a complete picture of what we are trying to do in Wisconsin without giving the background of our whole program. The measurement of scientific attitudes is only one feature.

A few years ago the Teacher Training Council in Wisconsin wrote a philosophy of education.[1] This has received wide recognition and is acknowledged as one of the outstanding statements of the purposes of education. As a follow-up to that philosophy of education a committee of science teachers was asked to interpret this philosophy in terms of science teaching. In this general philosophy "education is recognized as growth through problem solving so that the individual will act in such a way that he will make the greatest contribution to society and at the same time receive the greatest personal satisfaction." What specific contributions can science make in the accomplishment of this general program?

The Science committee was faced with the problem of deciding what method it was going to use in developing this philosophy. After many conferences and discussions, we finally decided we would go out to the science teachers in the State and get their reactions, opinions, and emotional responses, rather than digest available literature. No doubt this literature has had a great deal of influence on the thought reactions of these teachers, but we were more interested in what they really thought themselves, what things they were in favor of, and what they opposed.

In order to put these plans into operation, the committee organized more than 350 teachers into fifty-five different groups. The whole program was and still is cooperative. The groups held meetings. At regular intervals, summaries of reports were sent to the group leaders. The committee members attended meetings with as many groups as possible, (actually 30 different groups.) After a year's discussion, the committee met for three weeks and wrote the philosophy of science teaching.

In this philosophy we recognize the purpose of science is to develop the ability in the individual to solve the problems that confront him. To do this, he will need (1) a scientific attitude, (2) a scientific method of procedure and (3) a fund of information which will make it unnecessary for him to repeat what scientists have done before him. We opposed ranking objectives because all of them are important, and they are so closely interrelated that it is exceedingly difficult to say where one starts and the other ends.

We also listed fourteen specific objectives without any attempt to rank them. Neither did we try to place them in separate categories, such as attitudes, methods, interests, appreciations, because, as far as we knew, there was no commonly accepted line of demarcation between such categories. The fourteen specific objectives are:

1. Command of factual information.
2. Familiarity with laws, principles and theories.
3. Ability to distinguish between fact and theory.
4. Concept of cause and effect relationship.
5. Ability to make observations.
6. Habit of basing judgment on fact.
7. Ability to formulate workable hypotheses.
8. Willingness to change opinion on the basis of new evidence.
9. Freedom from superstitions.

* Digest of a paper presented to the New York State Science Teachers Association, December, 1934.

[1] "A Wisconsin Philosophy of Science Teaching." *The Wisconsin Journal of Education.* November, 1932.

10. Appreciation of the contributions of science to our civilization.
11. Appreciation of natural beauty.
12. Appreciation of man's place in the Universe.
13. Appreciation of the possible future developments of science.
14. Possession of interest in science.

It is not to be assumed that the philosophy is final. We had to begin somewhere. It is our working plan for the time being, and it will be revised as rapidly as we discover evidence which will help us revise it. The question is: Is this philosophy possible of attainment in the science classrooms? Will it work? If it does not work, what is wrong with it?

In order to answer these questions it becomes necessary to discover what is being accomplished in the classrooms. To do this it is necessary to have measuring instruments which will measure what is being accomplished. So our testing program in time will test for all of the objectives we have mentioned, both general and specific. With the exception of the fact or knowledge tests, we must explore the field in the testing of attitudes, methods, appreciations and interests. We really have no beginning ground; nor are we convinced that the so-called fact or infomation tests have reached their final forms. So we are constructing measuring devices as rapidly as we can proceed and still feel some security in what we are trying to do.

No doubt you are beginning to wonder when I am going to say something about scientific attitudes. I thought that presenting our plan first would lead you to appreciate more fully the difficulties we have had to face. There is much confusion about scientific attitudes. When does a person possess a scientific attitude or attitudes and when doesn't he? What are the characteristics of a person if he does have a scientific attitude? As I have stated before there was no satisfactory definition for a scientific attitude in the dictionary or anywhere else. Neither did we feel that a definition made by the committee would be generally accepted. We could see no reason why it should be. But we had to begin somewhere. We analyzed carefully the statements by Downing, Noll and Curtis because they were the most recent. Downing thinks of scientific attitude as an urge to do something. You either have this urge or you do not have it. As far as we could see he made but little distinction between emotional reactions and scientific attitudes. Noll says scientific attitudes and scientific thinking are the same thing. Curtis' statement is something like this—While scientific attitudes and scientific methods are of necessity closely related and inseparable, they are nevertheless distinctly different concepts. Many other statements were analyzed carefully in the same way with no more satisfactory results. However, we did succeed in getting a number of characteristics which might be considered as elements of a scientific attitude.

After much discussion we decided to send this list of characteristics, with a few more added which were contradictory to each other, to 250 well-trained, experienced teachers in all parts of the United States, 100 of them being sent to Wisconsin teachers. We recognize the questionnaire method is not entirely satisfactory, but it should yield better returns than mere guessing. We received 162 replies, 92 of which we kept for final statistical treatment. In many questionnaires of this nature the tendency is to agree with the intent of the persons making out the questionnaire. If teachers marked all of the statements as being characteristics of a scientific attitude, they were discarded. They had made no attempt to discriminate between the items. They agreed with the printed page.

We ranked the characteristics as selected by these experienced teachers, and finally accepted those which were chosen by at least 80 per cent of them. These are the characteristics which were finally selected:

1. Willingness to change opinion on the basis of evidence. (92%)
2. Search for the whole truth regardless of personal, religious or social prejudice. (89%)
3. Concept of cause and effect relationship. (86%)
4. Habit of basing judgment on fact. (85%)
5. Power or ability to distinguish between fact and theory. (82%)
6. Freedom from superstitious beliefs. (81%)

We can say then that an individual who has a scientific attitude will (1) show a willingness to change his opinion on the basis of new evidence; (2) will search for the whole truth without prejudice; (3) will have a concept of cause and effect relationships; (4) will make a habit of basing judgment on fact; and (5) will have the ability to distinguish between fact and theory. That is our definition of scientific attitude for the present.

The next task was to devise valid tests for determining the presence of each of these characteristics in an individual. There is the danger that when tests of attitudes are given the pupil will respond as he believes the teacher wants him to respond, rather than in a manner consistent with his own inclinations. It would be much easier to test for these characteristics orally if a teacher had time to do it, but under present conditions it could not be satisfactorily done on any large scale.

The first test we constructed was the cause and effect relationship test. Not only is it essential to know whether or not a pupil realizes that for any effect there must have been a cause, but it must also be ascertained whether the pupil recognizes the adequacy of a supposed cause to produce the given result.

We have 66 items in our present cause and effect relationship test. We have listed 66 pairs of occurrences, and we ask the pupils to judge each of the paired occurrences by checking it as:

A—if the first occurrence is practically the sole cause of the second.
B—if the first occurrence is one of a number of the important contributing causes of the second.
C—if the first occurrence contributes only slightly to the second.
D—if both occurrences are results of the same general cause or causes.
E—if the first occurrence bears no causal relationship to the second.

A few of the paired occurrences follow:

1. The sun shines on the earth; the earth is warm.
2. A boy often picked up toads; the boy had warts on his hands.
3. The light of lightning; the accompanying thunder.
4. The ignition switch of an auto is turned on; the motor starts running.
5. A rising column of air was cooled; a cloud formed.

The test was mimeographed and tried out with 295 pupils in six different high schools. The number of pupils' answers for each of these five divisions has been determined.

The committee felt it needed help in establishing the best answer, or acceptable answers, for each list of paired occurrences in the test. So we sent the test to 40 outstanding teachers of science and asked them to score the tests. We received the answered tests from twenty-five of these teachers, fifteen from outside of Wisconsin and ten from Wisconsin. (More papers were returned later.) We have answers from 295 pupils and 25 well-trained, experienced teachers.

A fact theory test was also constructed. This contained 103 statements. It was given to the same 295 pupils and scored by the same 25 teachers. The pupils were asked to check each statement for one of the following answers.

A. Some are statements of well established facts which are always true.
B. Others may be statements of well established theories which are generally accepted.
C. Others may be statements of theories which are questioned by some (many) authorities.
D. Others may be statements of popular beliefs which are not supported by evidence.
E. Column E is to be checked if you are not familiar with the statement.

Following are some of the statements used for testing:

1. A disease is a punishment for some particular moral wrong.
2. Air is composed of molecules.
3. The pressure in water varies with the depth.
4. Heating the molecules in air increases their speed.
5. A high forehead indicates high intelligence.

On the basis of these preliminary tests, some of which were given to teachers as well as to pupils, we feel we are justified in drawing some tentative conclusions:

1. High-school pupils in Wisconsin are not superstitious.
2. High-school pupils make almost as good records as the teachers.
3. Many of the theories in science are being taught as facts by many of our best teachers. Teachers as well as pupils fail to distinguish clearly facts from theories.
4. Pupils seem to have a fairly clear concept of the cause and effect relationship, but they do not seem to be able to recognize the adequacy of a supposed cause to produce the given result.
5. Many teachers tend to propagandize their material when there is no scientific evidence for the statements they make.
6. Teachers do not consciously attempt to develop the characteristics of a scientific attitude. If pupils have acquired these characteristics, it has come about by some process of thinking or experiences outside of the science classroom.

As a result of the suggestions of many teachers and an analysis of the statistical results, the first forms of the tests were revised. We now have them in printed form.

In September we gave tests to approximately 1000 pupils in eight high schools in Wisconsin. These tests were given in each school to classes in general science, biology, chemistry (if taught), physics and a class in which none of the pupils were enrolled in a course in science. We are going to give the same tests to the same pupils at the end of the school year next June. As a result of these tests we may be able to discover:

1. How well pupils are able to distinguish between facts and theories and how much they improve during the year.
2. How well pupils understand cause and effect relationships and what improvement they make?
3. How much each science subject contributes to the development of the different characteristics of a scientific attitude?
4. How much the number of courses in science contributes to the development of attitudes? Are two or three courses better than one?
5. What progress do pupils not enrolled in science make as compared with the different science groups?
6. Later we hope to show what effect different methods of teaching will have on the development of the characteristics of a scientific attitude.

We are now using the following method of treating the results statistically. I am not at all certain this is the correct method. We are assigning different values, for each item ranging from plus 2 to minus 2. If the pupil marks the question according to the accepted answer, he will be given a score of plus 2. If he marks an answer that could not possibly be the right answer he will be given a score of minus 2. If his answer is fairly reasonable, he may be given a mark of 0 or plus 1. These assigned values are based on the results made by the pupils in the preliminary tests and on the answers which teachers have given. We have also checked each statement in the tests for accuracy in textbooks and source books. It is possible then to get a score of plus 2, plus 1, 0, minus 1, or minus 2, on any item. It is believed that we will get a more refined statistical treatment by using these assigned values than we would by simply checking the answers as wrong or right. We hope to know more about the use of these assigned values when we have completed the statistical treatment for the 2000 tests we gave in September.

We are laying the groundwork for the construction of the other tests. We are having difficulty in getting the exact type of test we think we should use. In testing for willingness to change opinion on the basis of evidence we must discover:

1. What a pupil's present opinion is.

2. How much evidence does an average pupil need to have his opinion changed?
3. What is the best way to present this evidence?
4. How will we know that he has really accepted the evidence presented? How can we overcome the notion which is so common, "you believe what you want to believe"?
5. How will we know when the pupil has really changed his opinion?

One type of question we are experimenting with now is the following. (A) A man had his car oiled in a garage and after driving a few miles discovered that the bearings in his car had burned out. Should the owner of the car attempt to recover damages from the garage owner? Many other situations may be stated which include additional evidence, such as, (B) On examination the crank case was found to be full of oil; (C) The crank case was empty; (D) The cap which holds the oil in the crank case was found in the garage; (E) There was a crack in the crank case.

If a series of changes like these were given it should be possible for us to discover what a pupil's opinion is, how well he weighs evidence, and how well he is able to distinguish between the types of evidence given in the different situations.

In measuring willingness to change opinions on the basis of evidence, it becomes necessary to discover if the pupil can judge evidence in any particular case, not evidence in general. This ability to judge evidence in any particular case will depend to a large extent on a knowledge of facts in that case. If we can assume a pupil has a general knowledge of the facts in any case, then, it should be possible to present experimental evidence as discovered in recent researches and discover how the pupils react. Much of the information in our textbooks is inaccurate. Some of it may be easily contradicted by recent experiments.

A few statement in many of our textbooks may be used for illustration:

1. Wood decays by oxidation, or there is oxidation during decay. (Recent experiments seem to prove there is no oxidation during the decay of wood. This decay is caused entirely by fungi or other plant diseases.)
2. Squirrels bury nuts so they will have a supply of food for the winter, and the squirrels remember where they bury the nuts. (The evidence for this is the opposite from the statement made in many of our textbooks.)

Again, many statements are made ascribing certain intellectual features to definite physical characteristics in individuals. Some of the statements follow: (1) "A high forehead indicates high intelligence"; (2) "A square jaw indicates a strong will"; (3) "Red hair indicates a fiery temper."

Also, many statements in our health and physiology textbooks are inaccurate and have been made without much evidence to support them. In too many cases conclusions have been drawn on too few instances or on the personal opinion of some individual who could not be considered an authority under any consideration. In cases like these, we could give the statements in textbooks, ask for the student's opinions, then present the evidence, and ask them to interpret the evidence in terms of the original statements.

Our present methods of advertising provide a fertile field for the judgment of evidence. Let pupils read some advertisement, ask them to analyze the statements in the advertisement under the following divisions:

a. Statements of absolute facts—outright.
b. Statements of such a nature that the advertiser wants you to think the statement is a fact, and which is worded in such a way that the facts are not stated but intimated. The statement actually is a misstatement of fact.
c. Statements which are facts but they have no connection with the advertisement. The statements are irrelevant as far as the advertisement is concerned.
d. Statements in which evidence of some experiment is presented and which is intended to lead the reader to believe that the experimental evidence is the deciding factor in making the advertised product

worth while. The experimental evidence presented may have no connection with the so-called values of the product. For illustration:

"It dissolves in two minutes." What if it does?

"It cannot harm the heart." What good does it do?

"Five cups will not harm you." What good does it do? Why five?

You see advertisers know that people have faith in the results of experiments. They are using the methods of the scientists to mislead people, rather than give a true statement of facts. I am not inferring that all of our advertising is dishonest but too much of it is of such a nature that it tends to give values to products that do not have the values claimed for them. We must be on guard then to give pupils training in detecting falsehoods (lack of evidence) in the factors of life which depend so much upon honesty. They must learn how to judge evidence. They must train themselves to form their opinions on the basis of evidence. But pupils do not get this training by just learning the facts in science. They must be taught how facts are obtained, what facts are relevant in a situation, and how facts may be used to form correct opinions.

Three of the characteristics of a scientific attitude are similar and center around the idea of coming to a proper conclusion from evidence, or facts, rather than holding a prejudiced opinion. "Willingness to change opinion on the basis of evidence," "Search for the whole truth without prejudice," and "The habit of basing judgment on fact," can probably be tested with the same test. By definition, "Prejudice is an opinion or judgment formed beforehand," "It is a preconceived judgment or opinion," "It is the leaning toward one side of a question from other considerations than those belonging to it," "It is the unreasonable objection against anything." "It is an opinion or leaning adverse to anything without just grounds or before sufficient knowledge has been obtained." If a pupil has the habit of basing judgments on facts, he will search for the whole truth without prejudice and will be willing to base his judgments and opinions on evidence and facts.

It is not to be assumed that by adding the scores on these three tests we will have a single index of a pupil's scientific attitude. They are rather tests of characteristics inherent in a scientific attitude. We cannot assume that the scores on the individual tests are positively correlated. Measurement of a scientific attitude can only be achieved by the careful determination of specific elements.

The ultimate aim is not testing but improved teaching. We must convince science teachers by clear-cut evidence that teaching science for the sake of knowledge alone is not enough. We have no quarrel with teachers who insist on teaching scientific knowledge. We doubt that we can make advances in teaching scientific methods and attitudes without a good background of knowledge. But we feel that teaching knowledge alone is not enough and that we are neglecting many opportunities to give pupils the real values of science instruction.

THE RELATIVE INSTRUCTIONAL VALUES OF FOUR METHODS OF CORRECTING OBJECTIVE TESTS IN HIGH SCHOOL CHEMISTRY*

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PROBLEM

The primary traditional use of objective tests is to measure pupil achievement for the purpose of assigning school marks. If tests can be made to serve as an instructional device also, teachers and pupils alike will share in the benefits. This article reports a study in which the writer attempted to determine, as objectively as possible, the relative instructional values of four methods of correcting objective tests in high school chemistry, with respect to pupil learning and retention of subject-matter information. The four chemistry classes in the Newton, Iowa, Junior-Senior High School, during the year of 1932-1933 were the subjects in this investigation.

METHOD OF INVESTIGATION

The following methods of correcting objective tests were utilized. In Method I, the pupils checked all the incorrect responses. They were instructed not to mark the responses in any other way at this time. Following this, they were given a thirty minute supervised study period during which they were asked to write in the corrections for the items which they had missed. They were to indicate the correct responses, and then on the reverse side of the sheet, they were to make a brief statement giving an explanation of the answers to the items in question. Individual help was given by the instructor upon request from the pupil. The papers were turned in at the end of the study period for partial added credit. The papers did not leave the room at any time. The aim in this method was to place emphasis on pupil activity. After checking his errors, the pupil was encouraged to study the topics on which he had missed questions. In this way, time was spent where it was needed and not in considering items which someone else had missed.

Under Method II, the pupils checked the incorrect responses on their own papers as the teacher read the correct ones and made a statement of facts about each item. Further questions from the pupils were encouraged, but the instructor did not prolong the discussion unless the class raised these questions.

Under Method III, the teacher had checked all the incorrect responses on the papers before they were returned to their owners. The correct answers had been indicated, and brief notes of explanation, equations, and page references to the text book had been written in. The items were then discussed one at a time, but if no questions were raised about a given item no further discussion took place.

In Method IV, the teacher had indicated the errors, checked the correct responses, and given brief explanations, equations, and page references as in Method III. The items were not discussed one at a time, but instead the discussion was limited to such questions as arose from the teacher's instructions: "I have marked the correct responses on your paper for those items which you have missed. Note your errors and ask any questions you wish to about them."

* A summary of a thesis submitted to the Graduate Faculty of the University of Minnesota, in partial fulfillment of the requirements for the Degree of Master of Arts, 1934. Data are on file in the library of the University of Minnesota.

It is to be noted that Methods II, III and IV required approximately equal amounts of class time, while Method I required slightly more class time owing to the length of the supervised study period. Methods III and IV required a great deal of the teacher's time outside of class, while Methods I and II required none of the teacher's out-of-class time.

The examination for each semester consisted of four sheets of test items. Each of these four sheets had ten true-false statements, ten multiple-choice questions, and ten matching items. These four sheets were arranged so that one-fourth of the examination papers began with Sheet 1, followed by Sheets 2, 3 and 4. A second fourth of the papers began with Sheet 2, followed by Sheets 3, 4 and 1 in order. A third fourth of the papers began with Sheet 3, followed by Sheet 4, 1 and 2 in that order. The last fourth began with Sheet 4, followed by Sheets 1, 2 and 3 in order. This practice was followed to eliminate any differences which might accrue should all the pupils in each class consider the test items in the same order. In this manner the possibility of copying was reduced, and all four sheets of the test were placed in equally favorable positions.

During the eleven weeks of chemistry instruction prior to the first Initial Test, various methods were used in correcting tests. An attempt was made to see that the pupils had enough practice with each method to enable them to proceed without hesitation on all four methods of this study. Because of the short period of time and the practice effect which might result from various methods used in other classes, it was not thought necessary to use each method exactly in rotation.

In the first semester, the Initial Test was given at the end of the eleventh week of instruction, while in the second semester it was administered at the end of the tenth week of instruction. In giving the examinations, care was taken to standardize as much of the procedure as possible with reference to time limits, instructions, elimination of disturbances, and so forth.

During the first recitation period following the Initial Test, Sheet 1 was passed out to the pupils. They were instructed to place their pencils on the floor. Red marking pencils were passed out to them to be used in checking their errors. The teacher read the correct responses for the items on this sheet while the pupils checked the incorrect items. This was followed by a thirty minute supervised study period in which the pupils made corrections on their papers as previously explained in the description of Method I. The rest of the period was used for supplementary reading.

At the second recitation period following the Initial Test, Sheets 2, 3 and 4 were distributed to their owners, one sheet at a time. They were treated as explained previously in the explanation of Methods II, III and IV. In Method II, where the pupils corrected their own papers, red pencils were used as in Method I. The instructor arranged to give approximately equal amounts of class time to each of these three methods.

During the third class period following the Initial Test, the test for immediate recall was administered without previous warning. The test and the method of administration were the same as that of the Initial Test.

Six weeks later the test was administered again as a Delayed Recall Test to determine what the retention of subject-matter information had been. The method of administration was the same as that in the other two cases. This test was given without review or announcement. In the interval between the Immediate Recall Test and the Delayed Recall Test, review of any kind on the subject matter of the examination was avoided as much as possible.

RELATIVE EFFECTIVENESS OF THE FOUR METHODS

In order to determine the relative instructional values of the four methods of correcting tests, it was necessary that the mean scores on the Initial Test on each of the four sheets, for each class, be equal. Only when the mean scores on the various sheets are identical are the increments of growth for the various methods comparable. Since the difference between any two of the means is zero, the division of this dlifference by the standard deviation of the difference of these same means would give a quotient which would be zero.

To secure equivalent initial mean scores it was necessary to eliminate from consideration the data for certain test items. In a given class an equal number of each type of item was discarded from each of the four sheets.

The scores on the Initial Test having been obtained, the means and standard deviations of these scores for each method in each class were calculated. The same test items which were eliminated from consideration under each method, for each class, in the Initial Test were discarded in determining the scores on the Immediate Recall Test. The means and standard deviations of the Immediate Recall Test scores for each of the methods in each of the classes were then determined.

The determination of the increment growths in each method as shown by the means was the next step. The mean score of the Initial Test on any given method was subtracted from the mean score on the Immediate Recall Test to obtain the gain for this method. These increments indicate roughly the values of the four methods, but do not give evidence as to the statistical superiority of one method over another in comparable units.

The next step was to calculate the actual differences between the gains on the various methods as expressed in the means on the Immediate Recall Test. This was done by subtracting one mean from the other. For example, 22.10, the mean for Method II in Class I, was substracted from 21.17, the mean for Method I in the class. The obtained value of $-.93$ indicates the extent of the actual differences between the gains. This gain was divided by the smaller of the two means and the quotient multiplied by 100 to obtain the percentage of greater gain over that mean.

The reliability of the difference between the means was determined by finding the differences in the gains of the means and dividing this difference by the standard deviation of the difference of these same means. The formula to represent this step may be written thus: $\frac{D_M}{S.D.D_M}$. In finding the standard deviation of the difference of the means, the following partial formula was used: $S.D.D_M = \sqrt{\left(\frac{S.D._1}{\sqrt{N_1}}\right)^2 + \left(\frac{S.D._2}{\sqrt{N_2}}\right)^2}$. This value represents the standard error of the differences. There were only ten ratios having a value of .800 or more when this formula was used. The complete formula gives results considerably in excess of those obtained by the short formula. In five cases the resulting quotient is over 2.0, whereas, in the other five ratios the value remains below this figure. Since the ratios between .800 and .900 do not reach 2.0 when the long formula is used, it is improbable that ratios below .800 would be increased to attain this figure. Therefore, it did not seem necessary to compute all the other coefficients of correlation which would be required if the long formula were used.

Although the superiorities are slight, and the quotients are not of sufficient magnitudes to indicate high statistical reliability, it is worth while to search for trends which are somewhat consistent. The use of the complete formula would increase the values considerably. Even though no single ratio

indicates a statistically significant difference, if the same trend can be found in several classes, the significance which can be attached to the obtained differences is increased. If, in making comparisons of the gains obtained by any two methods, the superiority attaches itself to the same method in a majority of cases, it is not likely that difference is due to chance errors of sampling.

The rank of the four methods in each class was determined by counting the number of times a given method was superior when compared with rival methods. Method II ranked first in both semesters when the combined result on the Immediate Recall Test for all classes was considered. Methods I and III were of approximately equal value, while Method IV was quite consistently inferior. Method II was superior to rival methods in twenty-six comparisons out of thirty. Methods I and III each showed a superiority in fourteen cases out of thirty. In only five cases out of thirty did Method IV show greater gains.

Evaluated on the basis of immediate recall of subject-matter information in this particular situation, the superiority of Method II over the other three methods was quite evident. Likewise, the inferiority of Method IV was evident, while Methods I and III were of intermediate value.

The data from the Delayed Recall Test were treated in the same manner. As in the case of the Immediate Recall Test, it was found that these superiorities were slight, and no single ratio, as calculated by the partial formula, indicated a difference which was statistically significant. Hence, it was worth while to note consistent trends with which to evaluate the methods involved. These trends would be accentuated by the use of the complete formula.

The rank of the four methods was again determined. The superiority of Method II was further demonstrated by the results of the Delayed Recall Test. The inferiority of Method IV was likewise shown, while Methods I and II retained their positions as methods of intermediate value. Method II was superior to rival methods in twenty-two comparisons out of thirty. Method III showed superior results in eighteen cases out of thirty, while Method I was superior in fourteen comparisons out of thirty. In only six instances out of thirty did Method IV yield superior results.

When evaluated on the basis of the Delayed Recall Test of this particular situation, the superiority of Method II over the other three methods was again evident. Method IV was likewise shown to be inferior to the other methods. Method III surpassed Method I slightly on the Delayed Recall Test. Whereas these results are practically the same as those obtained in the Immediate Recall Test, the differences were not quite as great in the Delayed Recall Test. That is, the advantages of Method II over rival methods diminished somewhat during the intervening period of six weeks.

ACCURACY OF PUPIL CORRECTION

The accuracy of pupil correction must be investigated in a study of this type. Before Sheets 1 and 2 were corrected by the pupils, they had been checked by the instructor and a separate record made of all incorrect responses and omissions. The pupil correction was then compared with this record to determine the errors made by the pupils in checking the incorrect responses on the Initial Test. Three types of errors in correction were found. One of these was the incorrect counting of the number of errors after having checked them. The other errors consisted of failing to check a mistake and checking of an item which was correct. The majority of the papers were scored perfectly. To determine the percentage of error for any given class on a given method, the sum of the errors for that sheet was divided

by the product of the number of pupils in the class and the number of test items on that sheet, and then the result multiplied by 100 to obtain a percentage.

Method I was more accurate than Method II. In Method I the pupil's attention was concentrated upon the correction, while in Method II his attention was distracted by the explanation of the correct response.

The range of error was from zero to 1.9 per cent. The average error for both methods was below one per cent for both semesters. In other words, less than one error was made for every 100 items corrected. This high degree of efficiency would seem to indicate that the practice of having pupils correct their own test papers with red pencils is justified, when considered from the standpoint of accuracy.

CONCLUSIONS

The results and conclusions presented thus far apply directly to the situation described in this study. They are limited to the definite subject-matter information in high school chemistry as presented by the instructor during the semesters of this investigation. The limitations of the techniques and the examinations are in some measure responsible for the results obtained. These facts must be considered in the final interpretations of this study. In so far as the results of this investigation may be indicative, the writer contends that Method II is the most conducive to pupil learning and retention of subject-matter information.

The question as to whether this method of correcting objective tests in the secondary school is the best method for other instructors can not be fully answered here. The problem of "the best method" is one which each instructor should ascertain for himself by experimentation. After a desirable practice is formulated, it is well to modify it from time to time in order to improve upon it whenever possible. Any method requires constant revision to meet the individual differences in classes. However, the data presented here tend to substantiate the claims made for pupil correction of tests in previous studies. If the elements of time, interest, and instructional value are all considered the practice of having objective tests corrected by the pupils in class is worthy of consideration by teachers in the secondary schools.

Any instructional device which will lighten the routine duties of teachers, and thus give them time for more constructive endeavor, should be met with approval. The conclusions presented here imply that teachers may use successfully some method in which the pupils correct their own objective tests, provided the instructor accompanies this correction with explanations and class discussion.

ANNOUNCEMENT

Our readers will please note the change of address of the Business Manager as indicated on the Editorial Page. Correspondence relating to subscriptions, change of address, advertisements, and other business matters should be sent to—

Clarence M. Pruitt, *Business Manager,*
Colorado State College of Education,
Greeley, Colorado

Editorials and educational news

EDITOR'S NOTE

On previous occasions we have invited members of the associations using SCIENCE EDUCATION *as their official organ, as well as our readers, in general, to submit for publication editorials, editorial comments, and news items. We wish again to extend this invitation to all readers to the end that the journal may become a forum for the expression of views relating to any significant problem in the field of science education and also a source of information concerning events of interest to all science teachers.*

Formerly we have printed "Editorial Notes and Comments" and "News and Announcements" in separate sections. These two sections are now combined into a single section.

It is our plan to present in this new section editorials, editorial comment on new developments bearing directly or indirectly on science teaching, programs and reports of meetings of science teachers, and such other educational news as seems worthy and interesting.

With a special section for these types of material, the Editor believes that the journal may become more human in its values, and more significant to administrators and teachers of science at all school levels. We cordially invite our readers to contribute for publication items of the nature suggested herein.

HOW MANY ORGANIZATIONS OF SCIENCE TEACHERS?

Almost forty years ago twelve Chicago teachers met one Saturday night to dine and talk together. The menu was good, though I do not recall it, but the factotum had been told that science teachers should dine as well as business men. The topic, trend and one immediate result of the evening's meeting is doubtless still well-remembered by all living members of the group. The topic was "How can the service of science in education be improved?" The discussion developed the thought that science teaching needs more teachers who possess good scholarship and good professional training. One immediate result of the meeting was a decision to have the same group meet for dinner discussions once a month. For three years eight meetings per year were held, the last yearly meeting being participated in by both wives and husbands where such combinations existed. The topic each evening was opened by one who prepared in advance. The discussions were factual, virile and impersonal. No votes were ever taken. Indeed, it was agreed at the first meeting that any member of the group might always use any material or ideas presented in the group, but that no one was under any obligation to act in accord with others of the group. That is, the group existed for honest exchange of ideas regarding a common cause, rather than to gain agreement of a major-

ity for use in influencing or controlling others. The members of that group later went to various educational positions. When rare occasions now permit any two or three of the group to meet, the evident unselfish respect and mutual confidence provide one of the enduring pleasures of professional life.

There are many other kinds of science organizations. In cities of medium size there is often a general organization, including all teachers of secondary science. In larger cities the organizations usually represent special science subjects. State organizations and those including several states are common. The tendency has been for the larger territory and larger population groups to be organized about specific science subjects, the Science Section of the N. E. A. being a notable exception to this tendency. The National Association for Research in Science Teaching (N. A. R. S. T.) is national in its scope and purposes, but restricted in membership to those definitely concerned with research regarding science teaching. The newly organized American Science Teachers' Association (A. S. T. A.) is national in scope (including Canada), and proposes to serve those interested in any aspect of the use of science in education.

The N. A. R. S. T. has more than justified the hopes of its organizers, and like most worthy achievements, now seems to have visions surpassing those it had when it started. The improvement of both quality and quantity of exact studies about science teaching is its worthy goal. That is, the N. A. R. S. T. is working toward a scientific study of the educational uses of science. Its magazine has assumed a leading position in publication of research studies. Every ambitious and industrious science teacher should be encouraged to read this magazine regularly; indeed, he can illy afford not to do so. Although the work of the N. A. R. S. T. and its magazine represent a relatively small number of workers, the work itself is of large import to all science teachers.

The A. S. T. A. was organized in connection with the American Association for the Advancement of Science. It is open to membership by all teachers of science. Other science organizations may send delegates to the annual meetings, and individuals may also be members. In no sense is is restrictive. Meeting as it does with the winter meeting of the A. A. A. S., it provides occasion for science teachers to hear research programs related to the science subjects of their special interest. Then, of interest to all are the considerations of science teaching topics of national significance. The only authority of A. S. T. A. regarding science education is like that of the larger American Association for the Advancement of Science, which is the authority of good evidence. Votes even by majorities are sometimes absurdly unintelligent. The truths of science are not established by majority votes. The great obligation is to distribute knowledge with such supporting evidence as is available.

"But," says a young science teacher, "I can afford to belong to only one science organization. Which shall it be?" My answer would be, "Unless you change your attitude, it matters little which one you choose." Local conditions and problems surely demand the teacher's participation. State and sectional problems also call for participation. Research is always opening doors to new views for the science teacher. And participation in discussions of national problems, as well as scholarly growth through association with science leaders, would seem all but obligatory upon any teacher who cares to be more than a teacher of routine daily lessons about science.

Otis W. Caldwell,
General Secretary, A. A. A. S.

A NEW JOURNAL FOR SCIENCE TEACHERS

Number 1, Volume I, of THE SCIENCE COUNSELOR, a quarterly journal of teaching methods and scientific information for teachers of science in Catholic high schools, was issued last March by Duquesne University at Pittsburgh. We are pleased to welcome this new periodical, believing that it will fill a real need if the later issues maintain the excellence of the first two numbers in content, literary style, and typography.

The general purposes of the journal are stated in a paragraph of the March issue as follows:

> THE SCIENCE COUNSELOR hopes to help teachers by bringing to them authentic scientific information before it reaches textbook stage. It will call attention to modern and successful teaching techniques. It hopes to give its readers a progressive point of view; to inspire them to a careful and scientific study of their own problems; to encourage them to analyze and improve the teaching methods they use every day. The staff of this magazine will be glad to help them to cooperate in solving their common problems and to assist them in evaluating and applying the results of researches. The combined efforts and resources and influences of the teachers of science in the Catholic high schools can be both powerful and productive.

RETIREMENT—ENLISTMENT

Dr. Otis W. Caldwell, having passed the age of retirement from Teachers College, Columbia University, was voted the title of Professor Emeritus by the Board of Trustees, effective June 30, 1935. On that date his directorship of the Institute of School Experimentation ceased, though he continues in an advisory capacity on certain investigations in which he and his staff were engaged.

Our readers will be pleased to know that Dr. Caldwell's work as General Secretary of the American Association for the Advancement of Science and other scientific work will be continued from his office in the Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York, where professional communications may be sent after September 1, 1935.

It is our earnest and cordial wish that he may serve through many more years, with his usual vigor and helpfulness, the fields of science and science education.

NEW JERSEY STATE TEACHERS COLLEGES MEETING

The annual institute of the Association of New Jersey State Teachers Colleges and Normal Schools was held at the State Teachers College at Trenton on April 18, 1935.

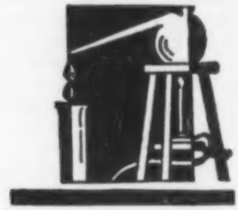
After greetings by President Roscoe L. West, the general meeting was addressed by Edgar F. Bunce, State Supervisor of Teacher Training, on the subject "New Aspects of Teacher Training," followed by Dr. Isaac Kandel, of Teachers College, Columbia University, who discussed "The Crises and Challenge to Educators."

The departmental science program considered the problem of preparation of teachers. The problem of "The New Four-Year Course in Science for the Preparation of General Elementary Teachers was outlined by Joseph Rosengren, of Jersey City Normal School, and the discussion was led by Guy V. Bruce, of Newark Normal School. The second problem, "What is the Proper Preparation for a Junior-High-School Science Teacher?" was presented by Dr. Robert W. McLachlan, of Montclair State Teachers College.

CENTRAL SCIENTIFIC COMPANY MOVES TO NEW PLANT

Central Scientific Company, manufacturers and dealers in scientific instruments and laboratory apparatus, reagent chemicals and supplies, announce their move to 1700 Irving Park Boulevard, Chicago, from which address *Cenco* products may be obtained in the future.

Abstracts



GENERAL EDUCATION

Carrothers, G. E. "Revision of Entrance Requirements in Michigan Colleges." *School Science and Mathematics* 35: 241–244; March, 1935.

The recent changes in the entrance requirements of the University of Michigan to make a student's admission contingent upon his being recommended on the basis of successful secondary-school work in two major sequences and two minor sequences of respectively two and three years and in five additional elective year units is believed by the author likely to "provide for at least a little further progress in each of the following accomplishments: (1) More harmonious cooperation between secondary schools and colleges for the good of the students each is called on to serve; (2) Opportunity for some pupils to pursue for three and four years in high school some of the subjects in which they have special interest and talent; (3) Special consideration for those pupils who seemingly have blind spots for a particular subject; (4) The development of better attitudes and the formation of habits of success instead of failure; (5) The provision of opportunity for choices, thus making it possible for teachers to insist on better work in the courses taken; and (6) The presentation of a situation that will stimulate and develop the special interests and abilities of boys and girls to a little greater degree than is now possible."
—F.D.C.

Maxwell, Walter K. "Do Junior College Students Study?" *The Junior College Journal* 5: 304–309; March, 1935.

This article is the report of a study of 156 students of the Phoenix Junior College. The student responses to a questionnaire inquiring into their habits with respect to study and recreation and their attitudes towards certain aspects of college life include these findings: The average student carries a student load of 15.6 hours; he studies 3.5 hours per day and 20.0 hours per week. The average student attends 3.3 shows per month; 2.9 dances per month; devotes 66 minutes per day to riding in an automobile, and 84 minutes per week to riding in automobiles for pleasure. The "average student participating in three or more school activities other than purely social ones not only studies as much or more than the average student but takes an hour more work." —F.D.C.

Eels, Walter Crosby. "Adult Education in California Junior Colleges." *The Junior College Journal* 5: 437–448; May, 1935.

This article reports the results of a study of existing practice with respect to adult education in the private and public junior colleges of California. Although the investigator discovered that much adult education is being provided in the various institutions he expresses dissatisfaction with the incidental nature of much of this education. He advocates that adult education of college level, as distinct from the high-school and the trade-school level have a distinct place in the programs of most junior colleges, and that information concerning the program of adult education should appear in the catalog of every junior college offering such work.
—F.D.C.

Mort, Paul. "Organization for Effective Educational Research in Colleges and Universities." *Teachers College Record* 36: 541–558; April, 1935.

The issues basic to research organization in college are: (1) the importance of the emphasis on technique in the early stages of science; (2) the place of pure research in the professional school; and (3) the issue of diversification of responsibility for research. There is need of more emphasis on pure research and also a need of more diversification of responsibility (among college professors) for research. Reasons for the changes made in guiding research of doctoral candidates at Teachers College of Columbia University from the former committee plan to the present sponsor plan are presented. —C.M.P.

Fairchild, H. P. "The Job Insurance Red Herring." *The Social Frontier* 1: 19–21; June, 1935.

The author points out the economic fallacies of proposed unemployment insurance schemes. He presents some very convincing arguments showing that unemployment insurance cannot in any sense be regarded as a solution of the unemployment problem and certainly not as a remedy or even an alleviation of the present desperate situation. What is needed is a job-guarantee system under federal supervision. "Only government is powerful enough and authoritative enough to put it into effect, and in this country only the federal government has the scope and the resources to make it adequate." —C.M.P.

Stein, Lucy, and Barry, May D. "Causes of Maladjustment of Some Problem Boys in a Junior High School." *California Journal of Secondary Education* 10: 305–312; April, 1935.

This is an extensive and careful case study of the boys who were sent to the office most frequently in one of the smaller junior high schools of San Francisco during the school year 1933–1934. Some of the conclusions of the study are these: ". . . different types of behavior problems cannot be handled to the best advantage in the same group." "One of the causative factors in the behavior problem boy in the junior high school is his inability to read. Further study is necessary to determine the defective readers who have not yet reached the discipline state." "Special remedial reading classes are needed at all levels, elementary, junior high, and senior high school." "Further study should be undertaken to determine the reading comprehension level that is required in order to achieve success in the various subjects in the junior and senior high school." "An unpublished study by one of the writers proves statistically that the arithmetic-reading age ratio is a more valid basis of classification in the junior high school than the mental age-chronological age ratio, and that the former has greater educational value." —F.D.C.

Givens, Willard E. "American Teachers as Citizens." *Phi Delta Kappan* 17: 54–58; December, 1934.

The teacher, supposedly a leader in the community, is often times denied even the full privileges of citizenship. The teacher has too often been a follower rather than a leader. The responsibility teachers have in the production of understanding citizens, and the qualifications teachers must have in order properly to assume such leadership, are discussed. A hypothetical representative of "self-centered, self-seeking groups and special interests" speaks to the teachers of America, defining the teacher's place in the scheme of thinking of this group. The "teacher-citizen" responds courageously.

—O. E. Underhill.

Bishop, Ernest G. "The Progressive School Versus the Modern Secondary School." *California Journal of Secondary Education* 10: 397–398; May, 1935.

The author challenges the claims of "progressivists" and the achievements in ultra-progressive secondary schools. His argument is summed up in this quotation:

"The progressive is prone to contrast his rosy picture with the familiar drab portrait of the dour dictator who barks his commands like a Prussian drill sergeant, insists on absolute regimentation of all classroom procedures, and demands unswerving allegiance to his sovereign will. Here the progressive, in order to make his picture stand out sharp and clear, ignores the modern situation and hearkens back to the school of fifty years ago. The fact is that neither the reactionary nor the progressive offers the ideal which present-day education seeks. Somewhere between these two extremes lies the golden mean. An instructor can allow his students as much freedom as is consistent with social behavior, can make his offerings attractive and palatable, and can permit considerable pupil leadership and initiative; and, at the same time, achieve desired goals of techniques, skills, knowledge, and improved social and ethical conduct."

—F.D.C.

Howerth, L. W. "Science and the Soul." *Kaldelpian Review* 14: 12–18; November, 1934.

The idea of the soul probably originates in attempts to make consistent every-day experience and the experience of dreams. Once established that man has a soul this is carried by analogy to plants and animals. The idea of the human soul as accepted by the majority of people is compared with the conception of the personal soul or spirit held among primitive races. At certain times in history men have denied possession of a soul to certain other groups. Ideas as to the nature of the soul have been greatly modified until it may mean anything or nothing. A woman or a cow may have a "soulful look."

"Theologians might be at a loss without the word. But as for contemporary science the word is obsolescent and should soon be obsolete. In psychology particularly the old idea of the soul must 'give up the ghost!'"

—O. E. Underhill.

MacKay, Donald William. "Four Challenges of the Junior College." *The Junior College Journal* 5: 342–345; April, 1935.

Discussing the topic from the standpoint of the service of the Eastern New Mexico Junior College to its state, the author states the four challenges to be these: (1) the junior college must "get its 'place in the sun' recognized by the profession, by leaders, and by the citizens of the state"; (2) it must formulate "its curriculum so that the largest individual development will come to each student"; (3) it must serve "the needs of the state as we find them, know them, and interrpet them" and it must give "particularly to the section of the state in which the college is located, a type of service peculiar to the needs of this section"; and (4) it must "serve outside the school as well as inside," that is, it must make its contribution to adult learning through "extension classes, parent education, trade education, school surveys, improvement of the job, cultural offerings, library facilities to isolated rural people, recreational centers under the guidance of college leaders, forum, program speakers, church leadership, discussion groups, radio programs," and the like. —F.D.C.

Boardman, Norman. "Are We Moving Towards a New Social Order?" *The Social Frontier* 1: 21–25; June, 1935.

The author is firmly convinced that we are moving toward a new social order with the following characteristics: (1) it is to take the form of a socialized collectivism; (2) it is to be built on the cornerstone of cooperation; (3) it is to be a classless society; (4) it is to be a planned society; (5) it is to be based on an economy of abundance; and (6) it is to make a peace world possible. At present we are trending toward facism in the belief of the writer, and to combat this trend he urges the three following radical measures: (1) revise the debt structure; (2) use the instrument of taxation, and (3) enact an amendment to the Federal Constitution recognizing the Right to Work. —C.M.P.

Symposium. "The Horace Mann School at Work." *Teachers College Record* 36: 647–709; May, 1935.

This issue of the *Record* describes the philosophy and the type of curriculum, and gives an evaluation of the type of program, carried out in the Horace Mann School, an experimental school of Teachers College, Columbia University.

The guiding philosophy is that the school is responsible for the total education of the child. It believes that there are four fundamental powers necessary to the complete education of the child: (1) the power to *Know*; (2) the power to *Do*; (3) the power to *Think*; and (4) the power to *Feel*. In order to develop these four attributes, the curriculum is derived from functional concepts from the fields of language, literature, mathematics, science, arts, and human relationships. This core of content has been divided into themes extending from the kindergarten through the high school.

The unit method, which is used, assumes three things: (1) since interest is a powerful factor in learning, the organization of subject-matter is made around topics or themes of interest to the child and dealing with the content to be developed; (2) if the learning situations in school can be made to approximate similar situations in life outside the school, reality is lent to the process of education; (3) learnings, in order to function in the mind of the child, must have meaning for him and in order for him to gain this meaning, the natural and existing relationships between varied types of content must be brought out.

Types of themes developed in the elementary school are used as illustrative material. The general theme for the Junior High School is the "Story of Progress of Man Through the Ages" subdivided as follows: seventh grade, the very earliest period of man; eighth grade, the ancient period to the discovery of America, and ninth grade, from the discovery of America to life in the modern world.

In the senior high school the theme is Modern Civilizations and Cultures subdivided as follows: tenth grade, American civilization and culture; eleventh grade, modern civilizations and cultures other than our own, twelfth grade, modern problems and issues in America.

An article by Gerald S. Craig and Alton I. Lockhart describes the continuous science program in the Horace Mann School, beginning with elementary science on the lower levels and cumulating with biology in the tenth grade and a two-year physical science program in the eleventh and twelfth grade. This physical science course of two years includes material from chemistry, physics, geology, paleontology, and astronomy. —C.M.P.

SCIENCE IN THE ELEMENTARY SCHOOL

Shontz, Geraldine. "Factors Conditioning the Development of Understandings in Beginning Science." *School Science and Mathematics* 35: 411–415; April, 1935.

The author accepts the thesis that it is desirable to introduce curriculum principles, concepts, and understandings into the elementary science. She discusses in detail these factors which condition the development and introduction of desirable materials: "(1) the difficulties which have to do with grade placement; (2) the philosophy and background of the teacher; (3) superstitions and unscientific beliefs which are traditional in many families and localities; (4) animistic treatment of science materials; and (5) the lack of sufficient suitable references." —F.D.C.

Randolph, Lucille. "Bird Study—A Unit for May." *The Instructor* 44: 38; 93; May, 1935.

A fifth grade unit relating to the study of birds, illustrated. —C.M.P.

Bacon, Ella. "Rabbits—Wild and Tame." *The Grade Teacher* 52: 32–33; 66; April, 1935.

This is a unit appropriate for the primary grades intending to show the value of rabbits to man and to increase children's love for rabbits as pets. —C.M.P.

Becker, Edna and Cook, A. E. "The Awakening" and "The Babes in the Woods." *The Grade Teacher* 52: 28–29; 51; April, 1935.

These are two plays relating to nature, suitable for the elementary grades. —C.M.P.

Boutwell, William Dow. "Keepers of the Great American Zoo." *The Instuctor* 44: 40; 74; April, 1935.

The author describes the work of J. N. Darling, the famous Des Moines cartoonist, who is now official caretaker of the United States Biological Survey Department. This article pertains especially to birds. —C.M.P.

Cohn, E. "A Unit on Rocks and Minerals." *The Instructor* **44**: 59; 75; June, 1935.

A fairly complete unit appropriate for the sixth and seventh grade, illustrated. —C.M.P.

Blough, Glenn O. "Let's Do an Experiment." *School Science and Mathematics* 35: 603–605; June, 1935.

The author describes the steps he follows in performing a laboratory exercise with a fifth-grade class. The pupils are first allowed to examine the apparatus to "clear up any mysteries that may surround even the commonest piece of apparatus." The next step is to make sure that "all pupils concerned know the reason for performing the experiment." The purpose when clearly established and understood as a problem is written on the blackboard. The children are allowed to participate in the experimenting and all are required to observe accurately and completely during the progress of the work. Reporting the experiment involves training in scientific method—formulating hypotheses, reasoning from data, and the like. The statement of the conclusion is followed by practical applications of the facts or principles involved in the demonstration. Recording the experiment in various ways suited to the nature of the problem and to individual differences in the pupils concludes the activity. —F.D.C.

Cummings, Bertha. "Our Animal Welfare Club." *The Instructor* 44: 35; 88; April, 1935.

The article describes the club activities of a fifth-grade class interested in learning and studying the care of animals. —C.M.P.

Ludeman, Ila. "A Unit on the Banana." *The Instructor* 44: 23; 64; April, 1935.

This is an illustrated unit on the banana—where it grows and why, its usefulness as food, and transportation and marketing. —C.M.P.

McDonald, Gertuude H. "Our Timber Crop." *The Instructor* 44: 49; 70; April, 1935.

An illustrated unit on forests, their value, products, conservation, and importance to posterity. —C.M.P.

Pease, Josephine von Dolzen. "Walking in the Woods." *The Instructor* 44: 34; 85; May, 1935.

A nature dramatization suitable for the fifth or sixth grade. —C.M.P.

SCIENCE IN THE SECONDARY SCHOOL

Weaver, Elbert C. "Modernizing the Introductory High-School Course in Chemistry" *Journal of Chemical Education* 12: 125–127; March, 1935.

With the great changes that have occurred in our high-school population during the present century, the traditional college-preparatory course in high-school chemistry no longer meets the needs of most pupils. It is suggested that the larger high schools, at least, may offer two courses in chemistry. Besides the college preparatory course, one which deals less with technical matters and more with practical life applications of this subject may prove more valuable to pupils who will probably take no chemistry beyond this first course. Some useful suggestions as to the nature of such a course are given. —V.H.N.

Paley, Henry. "An Approach to Creative Science." *Progressive Education* 12: 333–335; May, 1935.

The author, teacher of science at the City and County School, New York City, and at the Woodward School, Brooklyn, describes his approach to creative science teaching in the elementary school. He says "The science in our school is based on the philosophy that it should further first-hand experiences and so help bridge the gap from the phantasy world of early childhood to one of reality through understanding. It should help encourage the spontaneous curiosity so inherent in children, particularly when, as Freud points out, we think of 'the distressing contrast between the radiant intelligence of a healthy child and the feeble mentality of the average adult.' It should help orient the child in his new environment. It should finally develop a critical interpretation of the child's relationship to his environment."

The content of the laboratory used in teaching creative science is simple, containing things children may readily handle without fear of injury to themselves or to the apparatus. It is varied so that simultaneously, different pupils may work on different problems depending upon their interest.

By a number of illustrations, it is shown how self-initiated inquiry based on the child's experiences may become a vital part of the curriculum of the school. —F.G.B.

Watson, Donald R. "Making High School Physics Functional." *California Journal of Secondary Education* 10: 236–238; March, 1935.

This stimulating discussion of practical departures from the conventional physics course lists these among the features which are emphasized in the author's physics class: individual projects which "are definitely not themes or papers prepared on the basis of reading," but which include models of all types, charts, and graphs; group projects in which the individual pupils contribute parts of a mig undertaking, such as the construction of a Foucault pendulum; correlation of the work on sound with practical music, as

discussed and demonstrated by the band director and by pupils who play in the band; special reports on topics dealing with the phases of physics under discussion; extensive reading of supplementary material in both magazines and books kept in the classroom; fewer than the usual number of individual pupil experiments but more lecture demonstrations which may or may not be writen up by the pupils; differentiated assignments of problems so that the abler pupils will solve many while the less able will solve fewer problems but the latter will put extra time on other phases of the work better fitted to their interests and capacities. —F.D.C.

Krenerick, H. Clyde. "A Single-Period Laboratory, A Demonstrated Successs." *School Science and Mathematics* 35: 468–476; May, 1935.

Having experimented for twenty years with the single period for laboratory work in chemistry and physics, the author gives the reasons for his conviction of the superiority of the single-period plan over the double-period plan. He makes the following recommendations for success with the single-period plan:

The experiments should be designed and written for the single period, with the expectation that laboratory work will precede classroom discussion. The pupils should be given the laboratory instructions in advance of their experimentation and the instructions should be such as to demand preparation. The students should perform most of the experiments individually but all should perform the same experiment during the same period. Pupils should be required to record only data, computations, and conclusions, using a uniform system of tabulation which enables the instructor to check all records in a brief time at the close of the period. F.D.C.

Cunningham, Harry A. "Objectives in High School Biology." *School Science and Mathematics* 35: 462–467; 606–612; May, June, 1935.

The theme of this careful analysis is suggested in these statements" . . . biology furnishes much material which when properly selected, organized and taught should make large contributions to the intelligent solution of many of our individual and social problems . . ." ". . . we as biology teachers should concern ourselves in giving the biology which is needed." The keynote of the discussion is a stressing of the need for developing more effective teaching of the use of scientific method. F.D.C.

Obourn, Ellsworth S. "The Use of the Textbook in the Effective Learning of General Science." *School Science and Mathematics* 35: 285–291; March, 1935.

The author discusses the underlying aims and philosophy of the general-science course. He emphasizes as important aims the teaching of the scientific method, the inculcation of scientific attitudes, and the teaching of principles of science. His philosophy is well expressed in this quotation from the article: "It would seem to me that just as the learning cycle starts with practical problems from the life experience of the learner, it must culminate in experiences which demand the application of the learning acquisitions." —F.D.C.

Fyfe, W. H. "Science in Secondary Education." *The School Science Review* 16: 289–297; March, 1935.

When science was first introduced into the curriculum of the secondary schools great were the hopes thereof. The call for science teaching came first from such men as Priestly, Kingsley, Huxley. It was "hoped that children could be brought into direct contact with concrete phenomena such as readily engage their interest, and could through that interest be attracted to measure and compare them, to observe, to experiment and in general in investigate . . . and through their own explorations they would reach out to the truth of general conceptions. . . . largely inspired by the false motive of producing factory-fodder, the teaching of science has been largely factual. It has been unscientific, because it has deserted the scientific path of personal observation and experiment and substituted verbal information."

The rest of the article makes a plea for the reestablishment of science teaching on an active or heuristic basis. Granting that the heuristic system may result in lower test scores on present so-called science examinations, the author stoutly maintains that under this system boys and girls would *know* more *real* science and would gain a greater respect for and training in the scientific method. —C.M.P.

Schultz, M. P. "A Contract Method in High-School Chemistry." *Journal of Chemical Education* 12: 239–241; May, 1935.

This article describes a modification of the Morrison plan as used in one high school. The units are called contracts, and provision is made for recitation by each pupil individually to the instructor. The plan has met with marked success in chemistry and is now being tried out in biology. —V.H.N.

Barger, Thomas Morse. "Effectiveness of the Individual Laboratory Method in Science Courses." *Journal Chemical Education* 12: 229–232; May, 1935.

This article reviews briefly the work which has been done in an attempt to evaluate the various methods of conducting laboratory work in science classes. The author describes a method in which teacher and pupils together perform the experiment. In this method as many as a dozen pupils may participate in the demonstration, each doing a certain part. This method has been found both popular and effective. —V.H.N.

New publications

WEBB, HANOR A., and BEAUCHAMP, ROBERT O. *Science By Observation and Experiment.* New York: D. Appleton-Century Company, 1935. 721 p. $1.72.

The names of the authors is a guarantee of a good text. They have produced a book in line with modern pedagogy and current practice. The general plan is an inventory of a pupil's knowledge followed by textual material, special suggestions for observation and experiments and some form of test. The suggestions for the organization of the recitation are especially to be commended. The title "Science by Observation and Experiment" suggested to the reviewer a book in which experimental work would be developed in class, possibly by demonstration, as a foundation or groundwork of the text. Such is not the case. The text proper is free from demonstration and experimental material. "The Observation, Experiments, and Demonstrations" following the text in fine print suggest many trips for observations but rather little demonstration work to illustrate fundamental principles. This probably has an advantage that schools which cannot have materials for experimenting may use the textual material alone. Some teachers may feel that there is a loss in not giving the pupil the advantage of some of our more commonly used class demonstrations in which certain procedures are used to give the experience of drawing a conclusion and thus giving them a little insight into the methods of the scientist. Over 20 per cent of the book is, including the supplementary material in each unit, in fine print so that the amount of the material in the book is very large, certainly enough for the eighth and ninth grades for which the book is written. The fine illustrations add to the attractiveness of the book. It is a book in which any normal boy and girl will be intensely interested. —W.G.W.

FITZPATRICK, FREDERICK L., and HORTON, RALPH E. *Biology.* Boston: Houghton Mifflin Company, 1935. 611 p. $1.76.

Leaders in the field of science education rather generally believe that the knowledge content of high-school biology courses should be centered around the important principles of biology. This book represents an attempt to "emphasize those biological principles which have applications in everyday experiences." The content of the book is divided into seven units, with the materials of each unit centered around some biological principle. The units are as follows: Unit I, "The Changing Environment"; Unit II, "Protoplasm, the Cell, and the Organism"; Unit III, "Life Functions"; Unit IV, "Adaptations of Behavior and Structure"; Unit V, "Reproduction"; Unit VI, "Variation and Heredity"; Unit VII, "Plants and Animals in Relation to Human Affairs."

The treatment of each chapter is comprehensive and for the most part interesting. In addition to the regular explanatory text materials, each chapter contains a wealth of supplementary materials, that is, suggested activities, a summary of principles, guide questions, and a list of books to read. ELWOOD D. HEISS.

HUNTER, GEORGE W., and WHITMAN, WALTER G. *My Own Science Problems* (7th year). 431 p. $1.20; *Science in our Social Life* (8th year). 452 p. $1.28; *Science in our World of Progress* (9th year). 581 p. $1.60. New York: American Book Company, 1935.

These three books comprise a series of general science textbooks designed for use in the junior high school. According to the authors "the underlying theme for junior-high-school science should be first, at the lowest level, simple *knowledges* about the interesting and useful science in the immediate environment of the individual. In the second year *understanding* is more the goal; while in the last year *interpretation* and *application* of science are the desired outcomes. The philosophy of presentation should result in the ultimate generalization that man of all the animals is the only one who can control and artificially change his environment."

Each book is divided into units which are organized according to the Morrison plan. Each unit begins with survey questions to take stock of the general information possessed by the pupils. The survey questions are followed by a preview to explain the unit. Each unit is made up of problems with readings and laboratory directions, self-testing exercises for mastery of the problems, story tests to rephrase the problems; summary to outline the unit; a test on fundamental concepts to develop generalizations; thought questions that call for applications, science recreations and science club activities

to promote leisure-time activities and reference reading.

Much emphasis has been placed upon learning devices as a means of motivating the pupils to reason about environmental science. Cuts, graphs, cartoons, and diagrams are employed frequently throughout the books as learning devices. The cartoons are unique in this respect and they, no doubt, will prove interesting and stimulating to junior-high-school pupils.

Altogether these books are attractive in appearance, well illustrated, and so organized as to arouse and maintain the student's interest in science. They make a worthwhile addition to the rapidly growing list of junior-high-school science textbooks. —ELWOOD D. HEISS.

FISHER, CLYDE and LANGHAM, MARION L. *Nature Science. Book 1. World of Nature.* 93 p.; *Book 2. Ways of the Wild Folk.* 117 p.; *Book 3. Our Wonder World.* 113 p.; *Book 4. In Field and Garden.* 104 p. New York: Noble and Noble, 1934. $1.20 each.

This is a series of four books designed to acquaint boys and girls with common environmental factors, such as many kinds of plants, insects, birds, fur-bearing animals, frogs, toads, rocks, heavens, and the seasons. Each book is divided into two parts. The first part emphasizes the materials common during fall and winter and the second part those common during spring and summer.

In developing the various topics, a general plan is used in which interesting information is given in story form followed by suggested pupil activities and questions. In most cases, this is followed by poems and legends that relate to the topic.

The style is clear and appropriate for pupils in later elementary grades. The vocabulary has been checked with the Thorndike word list. Statements of important and helpful summaries are given in the margins. The books are beautifully illustrated by many full-page colored plates and by illustrations in black and white. At the close of each part of each book is a final review in the form of multiple choice, completion, and true-false questions.

These books provide interesting reading materials for science classes in elementary schools and should have a place in both school and public libraries. —F.G.B.

PATCH, EDITH H. and FENTON, CARROLL LANE. *Holiday Shore.* New York: The Macmillan Company, 1935. 150 p. $2.00.

This is a companion book in the series containing *Holiday Pond, Holiday Meadow,* and *Holiday Hill.* The authors tell many delightful stories about the life and habits of common creatures found along sea shores, such as snails, crabs, starfish, clams, sea urchins, and barnacles. In these stories information is given that answers many questions about sea-shore life that are commonly asked by children. Many beautiful and appropriate illustrations add to the interest, attractiveness, and value of the book.

Holiday Shore is a real contribution to science literature for children of elementary-school age and of special interest to those who spend their vacations at a beach along the coast. —F.G.B

FURBAY, JOHN HARVEY. *Nature Chats—A Year Out-of-Doors.* Lancaster, Penn.: The Science Press Printing Company, 1934. 255 p. $1.75.

This book consists of fifty-two essays on various nature topics arranged as a chronicle of happenings in the out-of-doors, season by season. Many illustrations in black and white and carefully selected poems form an integral part of the book. An appendix gives helpful suggestions on preserving plant and animal specimens. —F.G.B.

HARRISON, LUCIA. *Daylight, Twilight, Darkness, and Time.* Newark, N. J.: Silver, Burdett and Company, 1935. 216 p. $1.24.

Many relationships between human affairs and one's latitude and longitude are discussed in an interesting way. Some of the topics treated are: relation of human affairs to longitudinal differences in the nature of the seasons and to the number of hours of daylight; sun behavior at various latitudes; twilight; relation of time of day to longitude; navigation and surveying; time problems of the world traveler. There are many helpful maps and charts. The book is a ready reference for much useful material that is difficult to find in simple form. It is excellent for supplementary work in both general science and geography. —W.G.W.

HERRICK FRANCIS HOBART. *Wild Birds at Home.* New York: D. Appleton-Century Company, 1935. 345 p. $4.00.

This book is a classic of method and observations in bird study. Many years ago Professor Herrick in his work *Home Life of Wild Birds* first described and illustrated the results of his use of the tent-blind for the intimate observation and photography of living birds in the field. The present volume represents a "distillation of a life time of study." It comprises the essence of his former published writings and also offers a mass of entirely new data about birds.

In chapter one the author presents a detailed analysis and description of the method he employed in studying the habits of wild birds. His method depends chiefly upon two conditions: (1) the control of the nesting site, and (2) the concealment of the observer. Students of bird life who wish to make observations of their own will find many valuable suggestions and helps in this chapter.

Wild Birds at Home deals mainly with the period of mating, nest-building, and the care of the young, the most interesting period of the bird's life cycle and it shows clearly the play of instinct and intelligence in the birds' behavior and habits. It gives the fullest account available of the life of the nest of typical American birds.

The book is illustrated with striking and informative photographs of birds in life and in action. This book brings to the amateur naturalist and the scientific student alike a wealth of authentic information about bird life and an extraordinary adventure in bird lore.

—Elwood D. Heiss

WRIGHT, ANNA, and WRIGHT, ALBERT H. *Handbook of Frogs and Toads.* Ithaca, New York: The Comstock Publishing Company, Inc., 1933. 231 p. $2.50.

This is a guide book for the study and indentification of North American frogs and toads. Of each species, there is a plate of photographs from life and a two-page résumé of its characters and habits. Common name, scientific name, range, habitat, size, general appearance structure, voice, breeding and notes are dealt with in the treatment of each species. The photographs are excellent. This book should be very helpful to teachers, students, and naturalists.

—Elwood D. Heiss

CARLETON, ROBERT H., and CARPENTER, FLOYD G. *Comprehensive Units in Chemistry.* Philadelphia: J. B. Lippincott Company, 1935. 420 p. $1.20.

The chemistry course, as set up in this workbook, is arranged and organized on the basis of twelve "comprehensive" units, wherein "individual pupil activity is emphasized in terms of individual differences in ability, capacity, and interest." The processes are well integrated and are arranged in a logical sequence so as to stimulate and guide the student to focus his attention on facts, theories, principles, laboratory work, men of science and characteristic vocabulary.

The general plan for each unit is as follows: (1) The unit is defined by means of recall and review questions, a brief descriptive view of the entire unit and a list of the unit problems to be solved; (2) the assimilative material for the unit consists of textbook references for each of the unit problems, an introduction to each problem followed by demonstration, experiments, other learning exercises, summary of the learning products, and individual projects for the entire unit, under the general heading of "Materials for Enrichment"; and (3) the unit summary consisting of self-testing exercises and mastery tests on the unit. Although the technique of such a plan could be recommended as an aid in teaching high-school chemistry, the authors would have presented a more valuable contribution if the "units," selected, represented the "big ideas and principles" of the field of elementary chemistry. —Jack Epstein

FISK, EMMA L., and ADDOMS, RUTH M. *A Laboratory Manual of General Botany.* New York: The Macmillan Company, 1935. 137 p. $1.00.

This laboratory manual contains simple exercises dealing with the functions and structures of plant life. Each exercise is an independent project which can be performed, in part or as a whole, without any disturbance of the continuity of the successive laboratory work of the course. The exercises are based on the facts and principles of the subject matter of lecture and textbook study and so can be adapted to any elementary course in botany . . . the exercises being selected according to the assignments of the instructor.

The manual also provides suggestions for the demonstration of phenomena relative to the study and understanding of plant life.

The appendix of this manual offers general suggestions for the selection and preparation of materials used in the laboratory; these could be employed as exercises for the more rapid students.

—Jack Epstein

SMITH, GILBERT M., OVERTON, JAMES B., GILBERT, EDWARD M., DENNISTON, ROLLIN H., BRYAN, GEORGE S., and ALLEN, CHARLES E. *A Textbook of General Botany.* (Third edition revised.) New York: The Macmillan Company, 1935. 574 p. $3.50.

This book presents the subject of botany as a unit wherein emphasis is mainly on structures and functions of plant life rather than on abstract, advanced phases of the subject.

The material discussed is well adapted to an elementary course in that it deals with those phases of plant life which are familiar to the student because of their widespread occurrence in nature or because of their economic importance.

The chapters are arranged in a logical and sequential order, so giving a definite continuity to the course. The authors have attempted to avoid the use of handicapping terminology and technical terms throughout the text so as to relieve the student of the difficulty of comprehension and mastery of subject matter imposed by the use of new scientific terms.

As the result of these considerations, the material of the text is easily read and readily comprehensible—all of which makes for a good elementary textbook of general botany.

—Jack Epstein

WRIGHT, A. A., and WRIGHT, A. H. *Handbook of Frogs and Toads.* Ithaca, New York: The Comstock Publishing Company, 1933. 231 p. $2.50.

This is the first volume of a projected series called "Handbooks of American Natural History" and it serves as a most promising beginning. The true test of any such guide to a group of organisms is its applicability and usefulness in the field. In the relatively limited New York City region it was possible to key many of the indigenous species of frogs and toads with very little difficulty using the keys and species descriptions in this manual. There is no question that it will be of equal aid to naturalists in any section of the United States and Canada.

An excellent general account including a most helpful plate on the eggs of 24 species is followed by a key to the families of frogs and toads and then keys to the species and subspecies within

each family. Each species, subspecies, and variety is then completely described as to general appearance, habitat, range, voice, and breeding habits with many miscellaneous field notes appended. Each description is accompanied by a set of almost entirely new photographs from life of various phases in the life history of each form.

This handbook should be in the library of every student of Amphibia, amateur or professional.

—George Schwartz.

Allen, Arthur A. *American Bird Biographies.* Ithaca, N. Y.: Comstock Publishing Company, Inc., 1935. 238 p. $3.50.

Something new about our friends, the birds. It seems as if bird lore has been presented from every angle of approach, but now Dr. Allen has daringly given us bird autobiographies, without however any suggestion of affection or nature faking. These are charming bird sketches infused with the spirit feeling and characteristics of the birds themselves. Out of the fullness of knowledge, with a background of years of careful study, keen observation, and experience he presents the birds' methods of living, their nesting and migratory habits and their distribution in a manner altogether delightful. Note the opening sentences of the "Peregrine's Story"; "Prince of the predators am I, ace of the avian war lords, pirate of the air. You who shudder at the thought of death, who cringe at the approach of destruction, who faint at the sight of blood, listen not to my story. Cradled on the rocks of precipitous cliffs, nourished on the flesh of timid song birds, taught to ride the tempest and to kill for the joy of killing, I and my story are not for the faint hearted."

Only the student with something of the divine fire of the imagination can thus vividly present the spirit and life of the individual bird. This book is not for bird identification, no dry details of markings or classification are in its pages. Who seeks for this kind of information must read elsewhere. Here, however, the tyro and the expert alike will find the thrill of knowing each individual bird as a personality.

For the teacher a very important feature of the book is a series of questions covering the main facts in the life history of each species, the answers to be found in the autobiographies.

It is well printed, profusely illustrated with excellent protographs and full page plates, over 200 in all. Altogether it is a valuable and charming book that any bird student, bird lover or nature study instructor will wish to add to his library. —John J. Schoonhonen.

Green, George Rex. *Trees of North America.* Volume II. The Broadleaves. Ann Arbor, Michigan: Edwards Brothers, Inc., 1934. 344 p. $3.50.

This is a comparison volume to Volume I, *The Conifers.* The author, now professor of Nature Education at Pennsylvania State College, was an instructor for fifteen years in the Forestry School, and so brings to this work not only the knowledge of an expert forester but also an experience gained through coming in contact with the viewpoints and needs of teachers of science and other subjects. Thus the two volumes on trees constitute, for science teachers and laymen, probably the best single treatise and key on trees that has been written. The work is authentic, scientifically accurate, and readily usable by the teacher and student, even those with a minimum of knowledge of trees. The author seems to have kept constantly in mind the fact that the book is intended for teachers of elementary and secondary school science. There is a brief discussion of each family of trees, the various genus under each family, and the chief individuals composing each genus. Each individual tree is usually discussed as to synonyms, common names, wood, leaves, flowers, fruit, buds and twigs, bark, form and size, root system, distribution, growth and age, reproduction, value, and so on. —C.M.P.

Holmes, Harry N. *Out of the Test Tube.* New York: Ray Long and Richard R. Smith, Inc., 1934. 373 p. $3.00.

Almost three score books have been written for the laymen relating to the subject-matter field and chemistry. *Out of the Test Tube* is a worthy addition to an already meritorius list. It is the opinion of the reviewer that *Out of the Test Tube* excels most of the popular books that have been written in the field of chemistry. Quite often popular books have emphasized certain phases of chemistry and neglected other phases almost as important. This book has a most desirable balance, not only as to the various subdivisions of chemistry but also as to the treatment of the practical and theoretical aspects. Not enough of the latter phase has been emphasized to detract from its readability by the average layman and high school student.

The major theme of the thirty-two chapters in the book is that this is the age of chemistry, made possible by the success of the chemist in outwitting the forces of nature, and in many cases improving on them. The author points out the close relationship of chemistry to economics, the arts, transportation, health, national defense and world affairs.

The author is a professor of chemistry at Oberlin College and a past president of the American Chemical Society. —C.M.P.

Kane, Joseph Nathan. *Famous First Facts.* New York: The H. W. Wilson Company, 1933. 757 p.

In *Famous First Facts* the author records first happenings, discoveries and inventions in the United States. The several thousand famous first facts are listed alphabetically. There is also a chronological index and a geographical index listing many of the facts found in the alphabetical list. As one might surmise, the book is a rather extensive compendium of knowledge and ready source of information for science teachers and pupils on any level. It merits a place in any library. —C.M.P.

Boyer, Philip A.; Gordon, Hans; Clark, Arthur S. and Shilling, John. *A Learning Guide in General Science.* Chicago: Lyons and Carnahan, 1934. 322 p. $0.96.

The problem-experiment method of approach is employed in the guide consisting of twenty-four units more or less common to most general-science textbooks. It is not intended as a textbook *per se,* but rather as a supplementary book with numerous pupil problem-experiments. The twenty-four units contain over 200 problem-experiments. Each unit begins with an overview of the unit followed by a pre-test on the unit. Then follow a series of problem-experiments which have cross-references to eleven well-known general-science textbooks. A list of applications and questions for further study of the problems is found at the end of each unit. General science teachers will find this book a very useful one, regardless of the school situation in which they are teaching, or the textbook they are using. The approach is commendable and ought to be much more extensively used. Better learning of general science would undoubtedly result. While one might question sometimes the selection of the problem-experiments included, and the omission of others equally desirable, that is merely a matter of personal opinion. The same thing may be said regarding some of the questions asked and the illustrations used. Altogether it is a most commendable and useful book. —C.M.P.

Symposium. *Popular Science Talks.* Volume 7, 1929. 355 p. $1.50; Volume 8, 1930. 285 p. $1.00; Volume 9, 1931. 319 p. $1.00; Volume 10, 1932. 307 p. $1.00. Philadelphia College of Pharmacy and Science.

Each year a series of 13 or more popular science talks are presented by members of the faculty of the Philadelphia College of Pharmacy and Science. These lectures have been made available in book form and published under the auspices of the American Journal of Pharmacy. The versatility of these lectures may be judged by the tiltes of the various lectures. Volume 7: "The Modern Sun Cult," "The Romance of Beverages," "Soil and Sod," "Time—What Keeps It?" "How Much Do You Weigh?" "The Cosmetic Urge," "Snakes and Snake Protection," "Heart Beats and Blood Flow," "The Carbon Oxide Brothers Mon and Di," "The History and Mystery of Pyrotechny," "Little Drops of Water," "Evolution of the Motion Picture," and "Iodized Salt—A Food or a Drug." Volume 8: "The Chemist as a Detective," "Under Invisible Light," "Iodine, the Element of Doubt," "Seventy Years of Petroleum," "No More Pain," "Heat and Cold," "Dope—The Story of the Use and Abuse of Opium," "King Cotton," "The Rat Menace," "Trees," "Transparent Life," "The Story of Inks," "Sound Production and Reproduction," and "Ventilation and Comfort." Volume 9: "What is Gas?" "Radio-activity," "Over the Roof of North America," "Ice Cream," "Funguous Friends and Foes," "Under the Lime Tree," "Liquid Death," "How Do We See?", "Concentrated Sunshine," "Food Poisoning and Poisonous Foods," "What Fur," "Hum and Bug," "Silicon," "The Story of Alcohol," and "Milk—Cow's and Mother's." Volume 10: "Triumphs of Medicine," "The History and Romance of Bread," "Photons and Electrons," "The Modern Arsenic Hazard," "Yeast—in Welfare and Industry," "Aqua Philadelphia," "Useful Milk Products and Milk Preparations," "Gold—A King and a Servant," "Insect Friends and Foes," "Colloids—A Story About Particles," "Vitamins," "Copper—Man's First Useful Metal," and "Manufactured Ice Cream."

—C.M.P.

McKay, Roy H., and Beasley, Norman. *Lets Operate.* New York: Ray Long and Richard R. Smith, Inc., 1932. 361 p. $3.00.

Written in the vein of T. Swann Harding and the series emanating from Consumers Research, Incorporated, *Lets Operate* is in many respects their peer. Dr. McKay is an eminent physician and a Fellow in the American College of Surgeons. He asserts his great reluctance to write the book, but feels that people have a right to know concerning some of the facts and practices now carried on in the name of medicine. The author cites case after case in which the victim was not the victim so much of his disease as the victim of either incompetence or charlatanry, or both. (A feeling often shared by many besides the reviewer.) A close line of distinction is drawn between the surgeon and the physician and the author makes a plea for each to remain in his own especial realm. There are numerous so-called surgeons who should not be allowed to practice surgery and ought to be told that they can never develop the skills and techniques required in successful surgery. Although the profession has many quacks and charlatans, there are, proportionally, as many or more capable, sincere physicians and surgeons as any other professional group (including the teaching profession). But how many appendices have been removed because it is popular or the doctor needed some money!

The practice of numerous hospitals in permitting or even forcing inadequately trained internes to perform major operations (so they may gain experience at your expense!) is deplored. Dr. McKay makes out an excellent case against state socialism in medicine. His arguments almost convince the wavering reviewer! If you have ever had an operation or have been seriously sick, or ever expect to be, you will enjoy reading this book, and it may be, even profit from it from the standpoint of health as well as financially.

—C.M.P.

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